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R. H. STINCHFIELD, *Editor*

Editorial Office: 1102 16th Street, N. W., Washington 6, D. C.

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Let's Be Thankful . . .

Things Are Better

Jeff McDermid

FARMERS in the Midwest belt once raised cain consistently about reform, fair play, a place in the sun, and all that; but lately they are relatively quiet and conservative in most ways, and on the surface seem more satisfied. They even take long vacations wearing fancy slacks and variegated sport shirts. How come this change? Inquiring friends with less than a smattering of soil sense often come to us sages and philosophers of an elder era with captious queries intended to start a colloquy, and being partial to this subject in the time of bounteous harvests we go on record to testify that times and things have altered.

Blessed with better facilities, farmers get more sleep and relaxation than they used to, and the hard work and long hours which were once the bane of their existence have been reduced to a level that compares very favorably with other occupations. Of course, even this modern trend has had its slight drawbacks, especially in making less working room on farms for the younger generation born there. With less need for manpower than of yore, the average size of the farm family has dwindled, and more than ever do our farms supply the source of help wanted in cities. If as some aver, our farm population 25 years hence will be only about 10 per cent of the nation's total, then some mighty heavy readjustments are in the cards.

"Breeding much better beef and dairy capacity in cattle has also been a big factor hasn't it?" comes the next poser.

About that we do not quibble. Much benefit and economy have come to

farmers from that direction, both in better cows and better feed for them. But 15 years or so ago when the first surge of upward production began to result from universal herd improvement, it caught many farmers without enough skilled help. Factory wages and military duty combined to shoo away the reserve supply of know-how herdsmen and able milkers, easy to find in any town in former times. So a farmer with a good-sized herd of bulging baggers had to sweat and worry through it himself without asking the women and girls to adopt the European system of no discrimination about the sexes when it comes to making hay, milking kine, and cooking chow in double shifts.

The harassed boss man had to plow the land and fit it, seed his crops and harvest them, mix and haul and hoist his feed, milk by hand, grope around with a smoky lantern, figure rations by feeble lamp light, bathe his weary bones in a wash tub filled from the cistern pump, use a backyard specialty with poor reading facilities, and fork stable manure over two or three times from gutters to meadows.

ANOTHER query here: "I presume the reason for this easier life on the farm is easily seen by the tractors at work in the fields and doing belt jobs, and the absence of horses and mules in the farm scenery."

Yes, both windmills and foals are getting hard to find anywhere. But in their place you see long rows of poles and wires that transmit electric power. Hence today's farmer has a starter under his foot to take the place of all the fussing and feeding of horses, and a switch to push in the house and barn to give him all the magic of Aladdin.

"Then it's the tractor and the coming of electricity which yanked the farmer out of the doldrums?" questions another.

They are about equally responsible. But there is a difference between getting a tractor and obtaining electricity. A farmer can make his own decision about owning a tractor, order one, and have it in a jiffy from his dealer—along with repair parts and extras pronto.

But when a farmer starts to yearn for high-line juice to lift his work load indoors and out, he doesn't just get it "presto" by sending a post card to the nearest power station. No, it takes a heap of advance planning and surveying and organizing in a rural community to get all those wires stretched out there and the switches set to chop silage or milk cows. It takes lots of money and credit to finance a deal like that, and one lone farmer by himself can't get high-line current even though he boasts the highest testing herd and the least brucellosis and anthrax in the whole township.

Power is supplied finally to farmers by their own cooperative system, or the regional public utility company, or in some cases, by the local municipal plant. Some of the power comes from coal, a little from diesel oil, and a growing amount from water turbines at big dams. Whatever means are used, the end result spells "emancipation proclamation" for the tired farmer and his family.

ALL this and sundry other innovations have narrowed the wide gap that existed in our youth between the city slicker and the country rube. Economists who delve in devious digits have come forth with levels-of-living indexes. These show an enormous change. Taking as late a year as 1945 as the base of 100, the average county in the United States had a farm-operator level-of-living index of 75 in 1930 and up to 122 in 1950. This means a rise of 45 points or about 60 per cent. We acknowledge with frankness that all of that gap between urban and rural living conditions has not yet been closed. Naturally, these vary with the region and the income, as well as with

the productivity of the soil itself. I do not think we should ever forget that levels of living, like plants, depend mainly upon the land for permanency. Otherwise all you do by boosting living levels is to get some folks mired in hopeless debt.

As we said, the bright new things are here but their existence varies. Electric washing machines are used on 60 per cent of all farms, but only on 40 per cent in the deep South. Water

pumps run 38 per cent and 22 per cent respectively as above. Only 12 per cent of all farms have home freezers. The North has milking machines on 22 per cent of all farms, the South on but 2 per cent. Feed grinders are scarcest of all, something less than 5 per cent for all the country's farms. Mechanical refrigeration is present on 61 per cent of all farms and ice cooling on only 15 per cent.

Radio and television are the prime removers of stark isolation and loneliness. In 1950, 94 per cent of all farms had radios and only 3 per cent enjoyed television—with a rapidly improving situation in the latter since. In the space of 25 years, radio sets on farms jumped from 4 per cent to 94 per cent, so within a short while we will bring all the wrestlers and convention spellbinders to the farm sitting rooms. Question: how will that affect the old rural adage of "early to bed and early to rise?"

IN regard to television, how will it change the extension service program picture? Does it mean that our subject matter specialists need not travel so many miles attending meetings, but may set the stage and do the demonstrating right from the college campus? And how will it alter the excuse rural folks now have to go somewhere for the sake of enlightenment? Or will the tap-dancers, chorus girls, quiz shows, and boxing matches obliterate too many ordinary shop-talk programs intended for the farmer's guidance? Whatever happens, we are going to be ironed out in one huge piece, and subjected to many high-pressure influences which the independent farmer formerly escaped. Rare will be the farmer in these coming times who can maintain that much-admired trait of rugged self-reliance and privacy of cogitation.

It's too soon to brag heavily about the telephone situation on farms. Plenty of them still use the hoot and holler system. Phones on farms actually declined between 1920 and 1945. The best we ever had was about 38 per cent of all farms with telephone connections, and two years ago only 16 per cent of the Dixie planters used these devices for chatting and business dealing. The best phone record lies in the Western states today, but a national movement is afoot by private and public means to extend this necessary asset to health, safety, and sound business so it takes in a majority of the rural dwellings.

FARM housing is undergoing a vast but slow alteration. The early log cabins gave way to the upright and ell fashion, or the gallery and hall type of the South. Now we have a myriad of

(*Turn to page* 51)

Fig. 6. The head lettuce on this slightly acid, virgin, deep muck yielded around 9 tons per acre of exceptionally fine quality except between the stakes where no copper sulfate was applied and the yield was a scant 1 ton per acre of poor quality and a week later in harvest.

The Nutrition of Muck Crops

By Paul M. Harmer

Professor of Soil Science, Michigan State College, East Lansing, Michigan

EDITOR'S NOTE: *This is a continuation of Dr. Harmer's article which appeared in the October issue of this magazine.*

The Minor Elements

Discovery of the beneficial effects of the so-called minor elements on a number of crops when grown on muck soil resulted in greatly increased yields on most mucks and in changing some of them from decidedly unproductive to very productive soils. In this discussion the effects of five of the minor elements, copper, manganese, boron, zinc, and sodium on crop growth will be considered although one, sodium, should be classed as a major rather than a minor element if its abundance in the earth's crust were taken into consideration.

In general the greater the amount of growth response by a crop to a given minor element, the greater will be the likelihood of deficiency symptoms appearing in the foliage of those crops when grown on a deficient soil. Possibly deficiency symptoms, as shown in some peculiar abnormal leaf pattern or type of growth, have been overemphasized in recent years as a means of identifying the need of some certain minor element. Actually paying increases in yield may often be obtained

from the application of a minor element, even though that element may not have been so deficient in the soil as to result in the development of deficiency symptoms.

In Tables III, IV, V, and VI[5] are to be found lists of crops, grouped according to the amount of increased growth which they are likely to show from the application of four different minor elements applied to deficient mucks. In general the crops showing the greatest response to the application of a minor element are likely to require heavier applications of that element and those showing less response smaller applications.

Michigan muck farmers have been fortunate in that the several fertilizer companies supplying materials to them are willing to include the needed minor elements in the fertilizer as ordered by the grower. By agreement between the companies, the State Fertilizer Control, and Michigan State College, these minor elements will be added to the previously mixed fertilizers at the rate of 2½, 5, 10, and 20% in the case of copper and manganese sulfates, 2½ and 5% of borax, and 2½% of zinc sulfate. The fact that these percentages are permitted to be added to the previously mixed fertilizers makes the mixing so much simpler and more convenient to the companies making them that the growers are assured of obtaining the desired mixture. Thus a ton of 3-9-18 fertilizer containing 10% copper sulfate actually is made up of 1,800 pounds of 3-9-18 and 200 pounds of copper sulfate, the grower paying for these amounts plus a mixing charge.

It is advisable not to continue the application of some of the minor elements until large excesses have been added to the soil. With the exception of manganese sulfate on alkaline muck, it is not advisable to include large percentages in fertilizer that is applied in the row beside the seed, or as a side-dressing too close to the growing plant. In the case of borax and zinc sulfate, it is safer to avoid any toxicity to the crop by including a larger percentage in the broadcast fertilizer and none in the fertilizer applied in the row.

Copper. A large proportion of Michigan's organic soils are deficient in copper. In general there appears to be slightly more copper in the alkaline than in the acid soils, sufficiently more so that only Group 4 crops in Table III are likely to respond to copper on alkaline muck soil. In general the more

[5] The groupings of the several crops as to their responses to certain minor elements are based on our experience with those crops on Michigan muck soils. Further study may result in some slight alterations in these groupings.

TABLE III.—COMPARATIVE RESPONSE OF SEVERAL CROPS TO COPPER, APPLIED AS COPPER SULFATE ON ACID MUCK SOIL

No.	Degree of response of crop			
	1. None to slight	2. Slight to medium	3. Medium to large	4. Large to very large
1	beans	cabbage	barley	alfalfa
2	broccoli	corn	carrots	dill
3	celery	mangels	cauliflower	endive
4	parsley	parsnips	millet	lettuce
5	peppermint	potatoes	oats	okra
6	peas	spearmint	radishes	onions
7	rape	sugar beets	sunflowers	spinach
8	rutabagas	tomatoes	swiss chard	sudan grass
9	squash	turnips	table beets	wheat

acid the muck, the greater will be the percentage increase in crop yield when copper is applied. The application of lime, when needed, sometimes appears to accentuate the need for copper. The increase in yield resulting from a copper application on any copper-deficient soil is likely to be greater in a hot, dry than in a cool, wet growing season.

Copper deficiency appears in most responsive crops as a dying back, usually around the edges or at the tips of the leaves. Sometimes it can best be described as a premature maturity of the crop, with a yellowing (chlorosis) of the foliage and a dwarfing of the crop. On a decidedly deficient soil it may greatly reduce seed production. In the case of corn, it may appear as a striping of the leaves but, with most large seeded crops and potatoes, the deficiency symptoms may not appear unless the seed planted also was produced on copper-deficient soil.

If an acid muck soil has never received any copper, either in fertilizers, dusts, or sprays, the initial amount generally should range from 75 to 100 pounds per acre of copper sulfate for the crops in Column 4 of Table III, 50 to 75 pounds for those in Column 3, 25 to 50 for those in Column 2, and none to 25 pounds for those in Column 1. Usually the general crops in any column will be satisfied with 15 to 25 pounds per acre less than these amounts. Following the initial application, it is advisable to continue to include 2½% copper sulfate in the fertilizer applied each year for a copper-responsive crop until a total of 50 to 100 pounds per acre has been applied in the case of the crops in Columns 1 and 2 and 200 to 300 pounds in the case of crops in Columns 3 and 4. Since copper leaches out of the soil only very slowly under Michigan conditions, and only a fraction of a pound per acre is likely to be removed annually by a crop, it is probable that these totals will be sufficient for a considerable period of years and possibly for the life of the muck.

Muck land, which has been in production of celery, potatoes, or some other crop that has been sprayed or dusted for disease control in past years, frequently has received Bordeaux or some other copper dust or spray in amount sufficient to partially or completely satisfy the soil's deficiency. In such case little or no additional copper may be required. Trials have shown that the copper fungicides ordinarily used will satisfy the copper requirement of crops.

Manganese. The manganese content of alkaline muck soil is likely to be higher than in acid muck, but it is unavailable to the crop. Manganese deficiency can be corrected by the application of an available manganese com-

TABLE IV.—COMPARATIVE RESPONSE OF SEVERAL CROPS TO MANGANESE, APPLIED AS MANGANESE SULFATE ON ALKALINE MUCK SOIL

No.	Degree of response of crop			
	1. None to slight	2. Medium	3. Large	4. Very large
1	cabbage	alfalfa	barley	beans
2	cauliflower	carrots	corn	endive
3	cucumbers	celery	oats	lettuce
4	peppermint	mangels	peas	onions
5	rhubarb	parsnips	peppers	potatoes
6		rape	radishes	spearmint
7		sugar beets	table beets	spinach
8		tomatoes	wheat	sudan grass

Fig. 7. Onions on alkaline muck in 1948 (left) were curled and dwarfed because of manganese deficiency, while those at the right on slightly acid muck made normal growth. In 1951 the same field produced spinach that showed manganese and boron deficiency on the left and very good spinach on the right. A sidedressing of managanese sulfate and borax on the spinach produced marked recovery.

pound, such as the sulfate, or by applying sulfur and making the soil slightly acid, thus making available the soil's manganese for the crop's use. Unless the soil is acidified with sulfur, applications of available manganese must be made every year in amount sufficient to carry the crop to maturity, because any residual manganese is likely to become unavailable by the following year. Manganese applied in a fertilizer band, in a row application, or sidedressing is likely to remain available to the plant for a longer time than if it is broadcast and disked into the soil. Use of the manganese application on alkaline muck for one crop is more economical than that of sulfur but, over a period of years, the use of sulfur is more economical.

Manganese deficiency symptoms generally appear as a yellowing of the leaves, with veins of the leaves remaining green. In the case of onions, the leaves curl over and down after about six weeks of apparently normal early growth. Sometimes the tips of the leaves touch the soil. This is accompanied by a delay in bottoming of the onions so they may not mature. Manganese deficiency is more evident in a cool, wet than in a hot, dry summer. It may appear with the more responsive crops in a wet season, or on a poorly drained field, with a soil pH even as low as 6.2. Because the manganese in a very acid soil may be locked up by a liming application, it generally is advisable to include 50 to 100 pounds per acre of manganese sulfate in the fertilizer mixture applied to the first crop following application of lime.

The amount of manganese sulfate or of sulfur which should be applied depends on the crop being grown, on the degree of alkalinity, the depth to which the alkaline layer extends, and the pH of the underlying muck. With highly alkaline soil (soil pH 7.6 and higher), from 200 to 400 pounds per acre of manganese sulfate or 600 to 1,200 pounds of agricultural sulfur may be required for crops in Groups 2, 3 and 4, Table IV. With a pH around

TABLE V.—COMPARATIVE RESPONSE OF SEVERAL CROPS TO BORON, APPLIED AS BORAX ON MUCK SOIL

No.	Degree of response of crop		
	1. None to slight	2. Slight to medium	3. Medium to large
1	beans	broccoli	alfalfa
2	barley	cabbage	celery
3	carrots	cauliflower	corn
4	oats	celeriac	lettuce
5	onions	kale	mangels
6	peppermint	kohlrabi	peppers
7	soybeans	parsnips	spinach
8	spearmint	potatoes	sugar beets
9	sudan grass	radishes	swiss chard
10	tomatoes	turnips	table beets

7.2, about half of these amounts will be needed. If the pH is around 6.8 to 7.0, manganese sulfate may be needed for Groups 3 and 4 at the rate of 100 pounds per acre, especially in wet springs or on muck which is not well drained. At this pH, application of 200 to 300 pounds of sulfur may be beneficial for Group 4 and sometimes for Group 3.

Manganese, in the form of completely water-soluble sulfate, can be used in a series of Bordeaux or basic copper foliage sprays at the rate of 1 to 4 pounds per 100 gallons depending on the alkalinity, with as good results or better than if applied in the soil. On highly alkaline mucks with the more responsive crops, it is generally better to combine a sulfur application with a manganese sulfate sidedressing, or a sidedressing of the crop combined with a series of applications in spray. Where both sulfur and manganese are applied in one season, about half the amounts mentioned above should be used. Whenever sulfur is used, it should always be applied after plowing and leveling, then thoroughly disked in. The sulfured layer should not be plowed down deep for succeeding crops unless more is to be applied. Considerably more sulfur may be needed in following years if the alkaline layer extends to a depth of 10 inches or more.

Boron. Boron, like manganese, is likely to be more abundant in an alkaline muck than in an acid one, but it is unavailable to the crop. Unlike manganese deficiency, boron deficiency may appear in responsive crops on new acid muck of varying degrees of acidity. Where an application of lime is necessary in order to produce crops, the boron deficiency is likely to be aggravated by the liming. Application of sufficient sulfur to reduce the alkaline and near alkaline soil to a pH of around 6.5 is likely to completely correct the boron deficiency. It is obvious that sulfur cannot be used for this purpose on decidedly acid soil without seriously interfering with crop production.

Boron deficiency manifests itself in symptoms on some of the most responsive crops in Table V. Thus celery is affected by cracked-stem disease, one which results in the cracking into segments and peeling off of the ribs on the leaf stems, together with a loss of crispness and the development of a bitter flavor. The disease is likely to appear on any alkaline muck and may appear on acid muck which has not been fertilized to any extent. Heavy fertilization of acid

Fig. 8. Cracked stem of celery. An extreme case of boron deficiency, with squatty, spreading type of growth characteristic of the disease. Often this disease does not appear until near the end of growth but, where it appears in earlier growth, it can be stopped with a sidedressing of borax.

muck for two or three years is likely to result in the disappearance of the cracked-stem disease, probably due to boron impurities in the fertilizer. Girdle of table beets appears as a boron deficiency disease in a cracking on the side of the beets. A decay sets in and a scabby condition may follow around the beet at the surface of the soil until it is completely "girdled," hence the name. Boron deficiency also manifests itself in a yellowing of alfalfa, corn, spinach, mangels, sugar beets, and swiss chard, with a dwarfing in hot weather of the new leaves of spinach and members of the beet family, a cracking of the epidermal layer on the upper side of the leaf stem (petiole), and a distorted one-sided growth of the center leaves in later growth.

In Table V is presented a grouping of crops according to their response to boron, applied as borax. If the muck is alkaline, the crops in Group 3 are almost certain to benefit from borax and those in Group 2 may benefit. If the soil is acid, Group 3 crops are likely to show some benefit but Group 2 may not. Ordinarily on alkaline and near alkaline muck, 75 to 100 pounds of borax may be required as an initial application for Group 3 and 25 to 50 pounds for Group 2, with half of these amounts for succeeding crops of the same groups. On the acid mucks (pH 6.6 or less), the initial applications should be about half the initial applications for alkaline soils, and succeeding applications halved again for Group 3 and omitted for Group 2 if borax has been applied on the field for crops in past years. When celery and sugar beets exhibit boron deficiency fairly early in growth, the condition may be corrected by a sidedressing of borax and a fair yield still obtained. Toxicity from overapplication should be avoided, especially from application in the row.

Zinc. Only one crop, onions, has shown a zinc requirement on Michigan muck soil. Corn and beets are reported to benefit from applied zinc in some other states but, on Michigan muck soil, no benefit has been observed even when those crops are planted beside onions that showed marked improvement from a zinc sulfate application. Zinc deficiency symptoms may appear in onions, grown on new muck, for the first three or four years of cropping. It is more likely to occur on muck with somewhat inadequate drainage than on properly drained soil.

The natural zinc present in a muck soil generally appears to be concentrated in the surface few inches. When the muck is properly broken, the furrow is turned completely upside down and the soil from a depth of 14 to 18 inches is exposed at the surface. Onions growing near the break between

Fig. 9. The onions in rows 1 and 2 (in the foreground) and 5 and 6 (on the crest of furrows) show marked evidence of zinc deficiency. Row 3, which happened to be sown above the break between adjacent furrow slices of this newly broken muck, obtained enough zinc from the topsoil which was not entirely turned under so it made a normal upright growth. This situation is likely to be repeated until the land is plowed or zinc sulfate is applied.

adjacent furrows may obtain sufficient zinc but those on the crest of the furrows are likely to become dwarfed, a grayish yellow in color, and with tops that are curled and wavy. After the onion roots have penetrated the furrow slice, they obtain zinc from the original top soil and suddenly recover their normal color and erect growth. The delay in recovery is usually sufficient that mature bulbs are not produced. Wet conditions slow up root penetration and cause further delay in recovery of the onions.

Onion growers on new muck land are advised to include in the broadcast portion of their fertilizer application around 50 pounds of zinc sulfate per acre annually for two to four years. After the first plowing following the breaking, generally after the third crop, the zinc deficiency is likely to disappear permanently.

Sodium. Best known and cheapest compound of this element is common salt, sodium chloride. Forced to adapt themselves to a high salt concentration in their fight for survival, several crops, native in salt marshes or along seashores in Europe, apparently become able to utilize the sodium. This property seems to have been retained in their cultivated state, with the result that 14 crops (Table VI) have thus far been found which give paying increases in yield when salt is applied in addition to the regular muck soil fertilization. Leaving the potash out, with salt applied, generally results in a poor yield and sometimes a physiological breakdown of the plants.

The sodium-responsive crops fail to show any outstanding deficiency symptoms. Some of them have a greater gloss on their leaves when salt is applied but the rather weather-beaten appearance of the crop in the absence of the salt application is likely to be ascribed to the seasonal climate. Table beet leaves are likely to be greener with salt applied while most of the responsive crops are firmer and stand up better in the market.

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Science and the Cow Look at Pasture Forage as a Feedstuff*

3. Securing Maximum Utilization from Grasslands

By Marshall E. McCullough

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IT was the task of the two previous articles in this series to consider the type of digestive system possessed by dairy cows and their ability to make use of forages as a major portion of their feed requirements. In addition, the inherent changes which occur in the nutritive value of forages have been considered in relation to properly feeding the cow throughout the year. This paper will deal with the problem of taking advantage of this knowledge in an attempt to make full utilization of forages.

The dairyman has one primary objective in his business—securing maximum economical production from his farming enterprise. We cannot, therefore, simply say that only this feed or this practice should be used in the production of milk. Rather, the dairyman must take all available feeding materials and systems and attempt to put together those that will enable him to accomplish his objective.

Regardless of the system of feeding used by the dairyman in the production of milk, his one major problem in the use of forages is the securing of large quantities of highly nutritious forage for his cows. Experiments in every dairy section of the world have shown again and again that the usefulness of forages varies directly in proportion to their nutritive value. Thus we can state the problem very simply—how can the dairyman have available when needed an adequate quantity of forage of suitable quality to supply the feed nutrients needed by his herd? Since it is not within the purpose of this series to define the methods needed to produce forages, we shall confine our attention to the problem of properly utilizing the forages available.

In general, there are two factors which affect the production that dairy cows can be expected to give from a given amount of forage dry matter. First of all, the cow must be able to consume a sufficient quantity of the forage, and, secondly, she must be able to digest and metabolize sufficiently the forage which she has taken in to enable her to meet her maintenance requirement and have enough left over to produce the desired quantity of milk.

Factors Affecting Intake

At least three factors affect the quantity of forage a cow will consume during a 24-hour period: (1) The size of the cow's rumen; (2) the ease with

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* No. 3 and last in a series of articles.

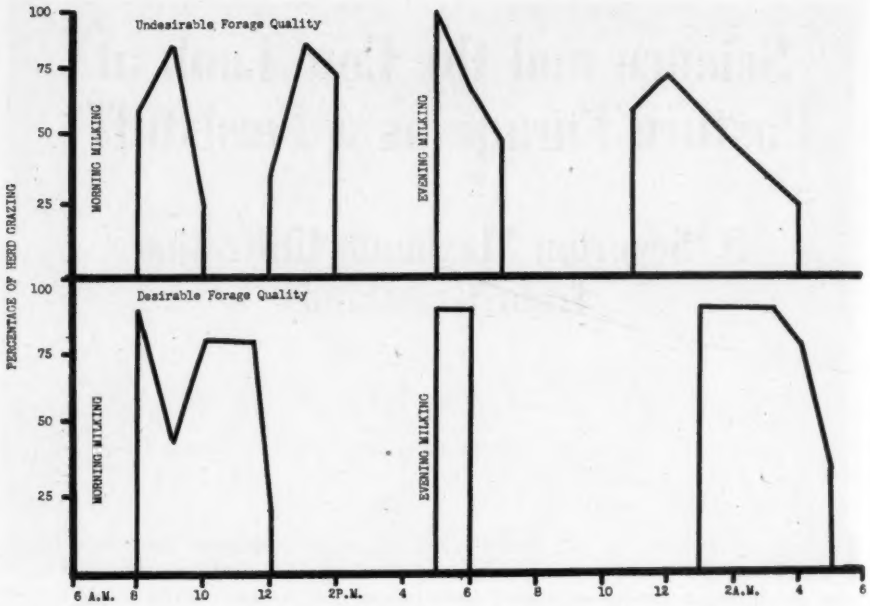

Fig. 1. Grazing periods on desirable and undesirable quality forages.

which the forage is broken down within the rumen, and (3) the amount of dry matter taken in per volume of forage intake.

At present there is little that can be done about the first item since it is an inherent characteristic of each cow. It would seem to be within the realm of possibility, however, that animal breeders may be able to select cows with larger rumen capacity and thus provide cows that have greater capacity without materially changing the over-all size of the animal.

The second item is almost entirely dependent upon the stage of growth of the forage. Essentially, the time required to break down and move forages through the rumen is a direct function of the relative digestibility of the forage consumed. Most work has shown that digestibility of forage dry matter decreases as the crude fiber, lignin, and other structural materials increase and the protein and simple carbohydrates decrease. In other words, as the forage plant ages, its digestibility decreases. This is well illustrated by the difference in digestibility found between the young growth during the spring months (70%-80%) and the digestibility of hay produced from the same forage cut at or near the seed-producing stage (50%-60%).

It must be remembered that unlike the hog, the cow chews much of her feed twice. Thus, time must be given the cow to graze a pasture and also time to ruminate or chew her cud. Since the urge to ruminate may actually reduce the time available for grazing, the cow must be able to consume large quantities of forages per unit of time spent grazing. For this reason, a study of the grazing performance of a cow is frequently a reasonably good index of the quality of the forage being consumed. Experiments in Scotland and the United States have led to the conclusion that best results are obtained from pasture forages when the cows tend to have two or three relatively long grazing periods during the 24-hour period. Typical grazing periods are shown in Fig. 1 for cows grazing on

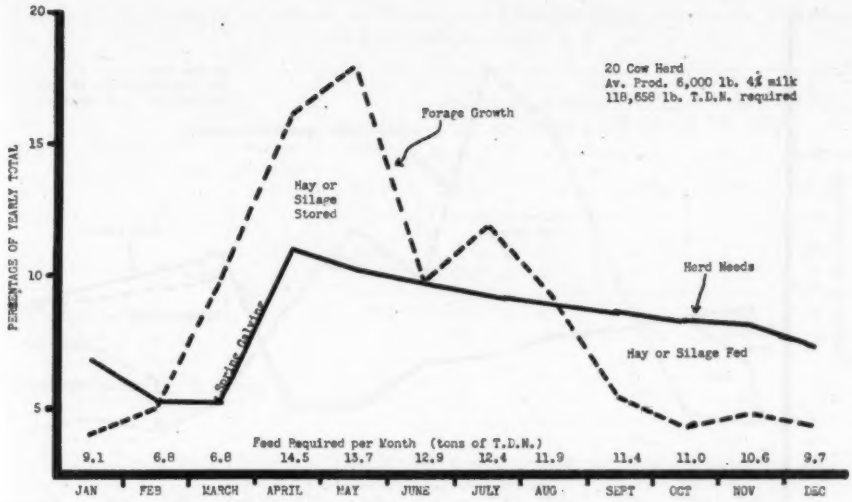
20
15
10
5
PERCENTAGE OF YEARLY TOTAL
20 Cow Herd
Av. Prod. 6,000 lb. 4% milk
118,656 lb. T.D.N. required
Forage Growth
Hay or Silage Stored
Herd Needs
Spring Grazing
Hay or Silage Fed
Feed Required per Month (tons of T.D.N.)
9.1 6.8 6.8 14.5 13.7 12.9 12.4 11.9 11.4 11.0 10.6 9.7
JAN FEB MARCH APRIL MAY JUNE JULY AUG SEPT OCT NOV DEC

Fig. 2. Production of low-price milk or production under adverse economic conditions.

an excellent and an undesirable type of pasture.

Close inspection of the grazing period will show that the cows on the undesirable forage exhibited four distinct grazing periods during the 24-hour period. Only once were all of the cows observed to be grazing at the same time and the total time an individual cow spent grazing during a given period was less than two hours. Such a situation could indicate one or more conditions. It might indicate that the forage being eaten was coarse and the cows were able to fill up their rumen with bulk in a short time, the forage was unpalatable, or that the material was of low digestibility and the cows needed long periods of time to ruminate.

The grazing performance of the cows consuming the desirable forage is typical of that observed under conditions of high intake, good digestibility, and high milk production. The cows have two long grazing periods and not more than one or two shorter periods during the 24 hours. Such conditions indicate that the forage being grazed is capable of permitting the cow to take in sufficient dry matter of high digestibility to sustain excellent milk production. In any consideration of this sort, it must be remembered that the cow is concerned only with eating enough forage to give her a feeling of fullness and well-being. Ideally, therefore, the desired forage is one that will enable the cow to consume the largest quantity of dry matter per volume of intake.

Factors Affecting the Quantity of Nutrients Available

The quantity of nutrients available to the cow from the forage taken in from a pasture is directly dependent upon the digestibility of the nutrients in that forage. Holmes and many other investigators have shown that the basic factor determining the feeding value of grassland products is stage of growth. In general the most nutritious grass is young immature forage, mainly leafy and fairly rapidly grown. It should be noted that the greatest dry matter intake is usually obtained from such forage. Such forages permit cows to produce large quantities of milk without further feed. However, as pointed out in a previous article, such forages are not balanced rations since they contain excessive quantities of digestible

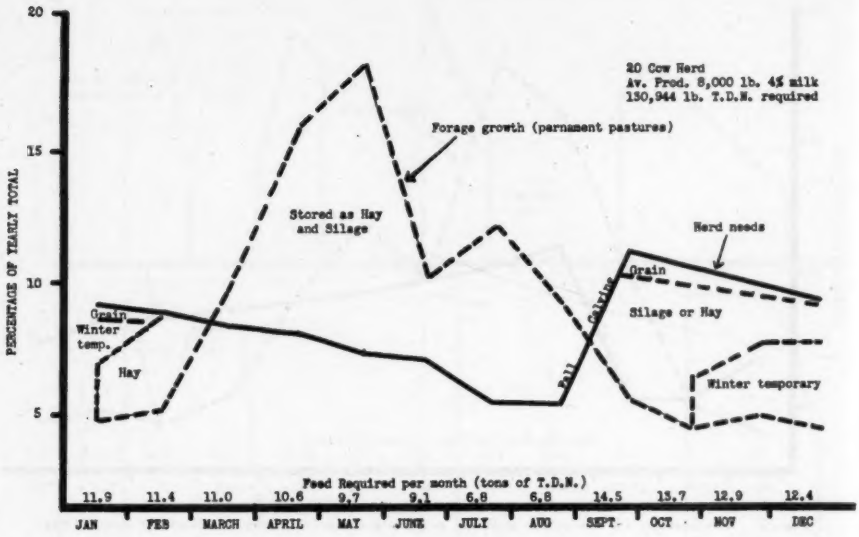

Fig. 3. Grade-A production system of dairying. (Based on permanent and winter temporary pastures.)

protein and are therefore deficient in energy-producing components. Also, the very nature of the forages makes them difficult to maintain over a sufficient length of time and thus would permit such production for only a limited period.

Table I has been prepared to show the magnitude of the relative unbalance of two forage types. The problem of supplementation was considered in a previous article. It should be pointed out, however, that maximum utilizations of the desired type of forage cannot be obtained by permitting free grazing. Since such forage can be produced only by supplemental crops, frequent clipping, or short period rotational grazing, the cost per unit of forage is frequently greater than it would be under a system of production utilizing less desirable forages.

Maximum Forage Utilization with Different Systems of Dairying

Much of the current interest in grassland farming is directed to permanent type pastures. Unfortunately, the available production whether considered on the basis of seasonal production of dry matter or in terms of seasonal changes in nutritive value of the forage is rather inelastic in the case of this type of pastures. Theoretically, it should be possible to adapt the production of the dairy herd to meet these seasonal peaks in forage production since the demands of the cow are more elastic than the production of the forages. Had our milk production enterprise been founded on the production of manufactured products alone, such would probably be the case. However, most of the milk produced in the Southeastern States is and probably will be for several years essentially a Grade A enterprise.

Two characteristics of such an enterprise exert a profound effect on the feeding system that can be used: (1) A large quantity of milk is required during the winter months; and (2) systems of payment for milk are so arranged as to encourage financially the dairyman to practice fall freshening and heavy winter production. Therefore, much of the elastic nature of the cow is lost, and a feeding program that will permit production during the season in which forage production is at

TABLE I.—NUTRIENTS SUPPLIED BY HIGH- AND LOW-QUALITY FORAGE IN RELATION TO THE COW'S NEEDS

Forage	Consumed per day lb.	Supplement type	Pounds supplement required to produce the following quantities of 4% milk*				
			20 lb.	30 lb.	40 lb.	50 lb.	60 lb.
High-quality forage which will supply .70 lb. T.D.N. and .20 lb. D.P. per lb. of forage	30	protein	0	0	0	0	0
		T.D.N.	0	0	0	3.0	6.2
	25	protein	0	0	0	0	0
		T.D.N.	0	0	3.3	6.5	9.7
	20	protein	0	0	0	0	0
		T.D.N.	0	3.6	6.8	10.0	13.2
	15	protein	0	0	0	0	0
		T.D.N.	3.9	7.1	10.3	13.5	16.7
Low-quality forage which will supply .60 lb. T.D.N. and .10 lb. D.P. per lb. of forage	25	protein	0	0	0	.35	.70
		T.D.N.	0	2.6	5.8	9.0	12.2
	20	protein	0	0	.4	.85	1.3
		T.D.N.	2.4	5.6	8.8	12.0	15.2
	15	protein	0	.45	.9	1.35	1.8
		T.D.N.	5.4	8.6	11.8	15.0	18.2

*Calculated on the basis of a 1,000-lb. cow above maintenance requirements.

its minimum must be followed. The problem becomes one of making maximum utilization of forages in order to minimize the quantity of concentrates needed.

Finally, we shall consider three types of dairy farming common to the Piedmont area in relation to such efforts to fully utilize available forages. These systems are shown diagramatically in Figures 2, 3, and 4. All values designated in the curves are in terms of monthly percentage of the yearly total. The monthly percentage of growth represents an average of the expected growth that would be available from pastures consisting of ladino-fescue, Bermuda seeded to Dixie crimson clover, and lespedeza seeded to crimson clover. The curve of monthly dairy herd requirements represents the calculated T.D.N. required to feed the size herd in question including the growth and maintenance of enough replacements for 25% of the herd each year. The forage growth indicated for the temporary crops is in terms of using Starr millet in summer and a mixture of oats, rye grass, and crimson clover during the winter. It should be pointed out that the data are not in terms of acreages or specific yields of dry matter per acre since conditions vary from farm to farm. It is assumed that the dairyman has a balanced program of forages suitable for supplying the needs of his herd.

Figure 2 illustrates a dairy program depending entirely upon permanent type forages to supply the entire feed requirements of the herd. Such a system best illustrates the production of manufacturing type milk with spring calving and the feeding of no grain to the milking herd. While in common use in some areas, it is not a recommended practice unless the farmer is willing to accept the resulting cut in total milk production (20%-30%), economic conditions make the use of

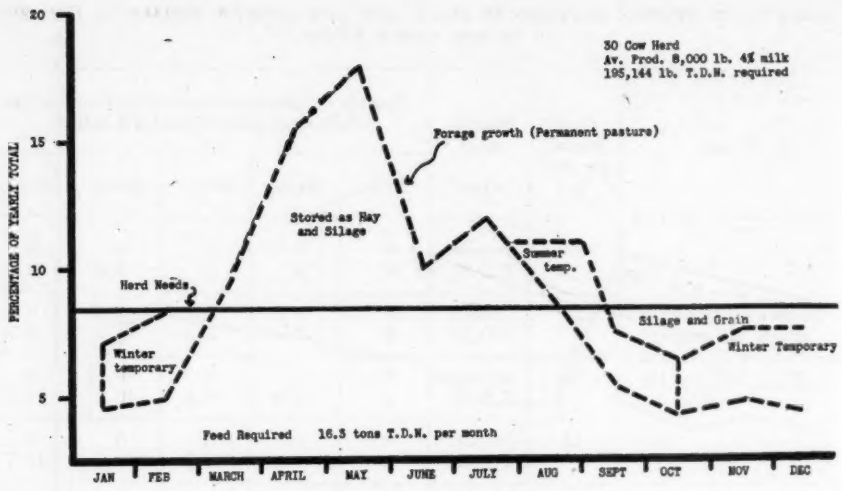

Fig. 4. Producer-distributor system of dairying. Maximum use of temporary pastures.

grain feeding too costly, or the herd is maintained as a small side line to other major farm enterprises. It should be pointed out that such a system of feeding is in wide use in other countries of the world, notably in Great Britain and New Zealand. Under the prevailing climatic and economic conditions in those areas it undoubtedly offers the most, but its use in the United States is and probably will remain a questionable practice in most areas.

The system is characterized by a high percentage of the production of forage during the late spring and early summer months with a small peak during the early autumn. Thus the high-quality forage needed for high milk production is available for only a two- to three-month period during the year. Preserving a part of the forage during the excess growth period in the form of grass silage would aid the situation from a quality standpoint but would lower the total yield since it would be cut in an immature state. From a forage standpoint, the system is the ultimate in inelasticity and provides no safety provision in case of drought or crop failure.

Figure 3 represents the most common production scheme since it depicts the production of Grade A milk along with fall freshening and the use of some temporary forages. The use of permanent pastures has a greatly reduced potential in this system because the peak growth is made even less usable by the lack of forage need during the spring and summer period. The surplus production could best be harvested as a combination hay and silage crop. The silage would then be fed during the late summer and early fall months when the quality of the available pasture is low, and the hay fed during the winter months when the quality of the forage is high but a good source of carbohydrates is needed. Perhaps the best use of grain during the year would be during the first six or seven months of the lactation of the cows. The use of a summer temporary forage in this system is open to debate since the peak of its production would come before the herd was ready to make full use of it. It should be considered, however, because such a high-quality forage available during calving season would probably serve to get the cows

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Deficiencies of Secondary and Micro-nutrient Elements in Plants

By J. E. McMurtrey, Jr.

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ATTENTION was originally directed to the primary elements most commonly deficient in soils for normal plant growth, namely nitrogen, phosphorus, and potassium. Later, it was recognized that the secondary elements—calcium, sulphur, and magnesium—often are required as soil amendments for successful plant culture. Working with the tobacco plant, it has been found possible to bring out the necessity for these elements in a variety of field soils.

Due to the fact that complex materials supplying the primary and more or less of the secondary elements were commonly used to prepare the fertilizer mixtures, it was not at first evident that even the secondary group was required. The trend in recent years to the use of fertilizer salts of comparatively high purity has focused attention on requirements for all nutrient elements. While the primary and secondary groups are frequently in short supply in diverse agricultural soils, the micro-elements have been assuming one by one an important position in agriculture. This group of elements including boron, copper, iron, manganese, molybdenum, and zinc are now receiving well-deserved attention. It appears logical to assume from our work with tobacco that other elements may be added to this list as we gain additional knowledge of plant requirements.

The specific effects of each essential element necessary for plant growth furnish a working approach to the problem. Since they are mainly growth phenomena, the distinctive effects on plant development produced by a deficiency of any one of the chemical elements essential for metabolism may be modified to a certain extent by other conditions controlling growth. Among the modifying influences may be mentioned light, temperature, and under field conditions, particularly, the amount and distribution of rainfall or other source of water supply. It is to be recognized that environmental conditions may modify rate of growth and therefore the rate at which the medium must supply necessary elements as well as the total quantities of these elements required. However, the characteristic symptoms due to a deficiency of an element will be found to remain essentially the same. There is often the question as to whether an essential element simply functions in certain metabolic processes or plays a role in the phenomenon of antagonism which is non-specific. A classic example of this situation is for the element magnesium which functions as an essential constituent of chlorophyll and also may antagonize calcium or other cations. There may be numerous other functions for magnesium which we do not understand at this time.

A shortage of one of the micro-

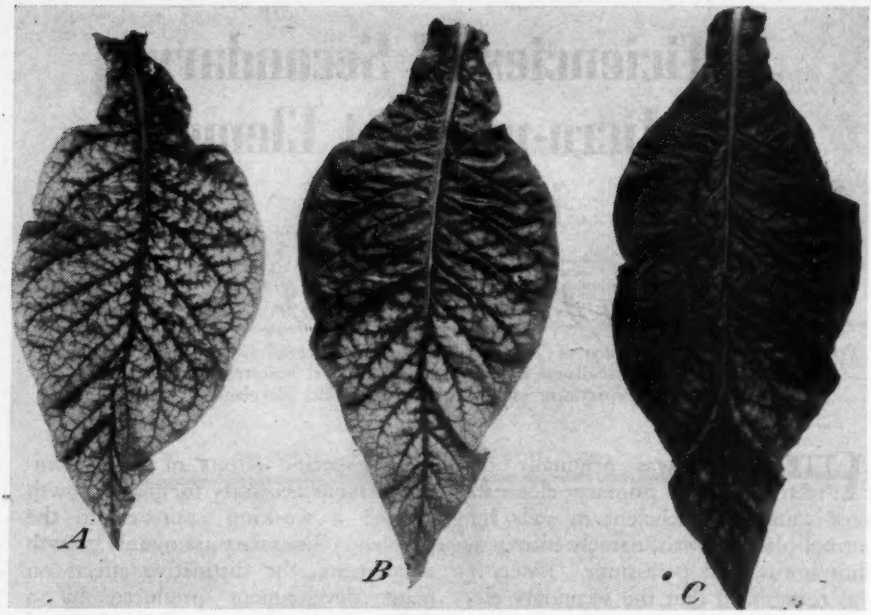

Fig. 1. Tobacco leaves showing chlorosis distinctive of magnesium shortage. These leaves represent stages of chlorosis which may be found on an individual plant from its base (A) upward (B) and (C).

elements essential for plant growth was one of the first to emphasize a typical plant symptom as due to a deficiency. Gris in 1844 and 1847 (36, 37) reported that a shortage of iron resulted in a chlorosis of plants. Chlorosis in plants and iron deficiency have since become synonymous terms.

French workers were the first to point out the importance of the group of elements required by plants in small amounts including boron, manganese, and zinc. Later work confirmed these findings. There have been several extensive bibliographies dealing with the elements required for plant growth in small amounts. The annotated bibliography originally compiled by Willis, (79) now in the fourth edition lists numerous papers.

Magnesium

While magnesium cannot be grouped with the micro-nutrients, it serves as a striking example of how the plant manifests a distinctive chlorosis when the supply is inadequate. It was generally assumed that most soils supplied adequate magnesium for normal plant growth until the work of Garner, McMurtrey, and Moss (Fig. 1) was published in 1922 (33). Sand drown, the characteristic chlorosis of tobacco resulting from magnesium deficiency, was first described and illustrated (32) (Fig. 2) in 1923. The most evident symptoms, depending on the plant involved include chlorosis, necrosis, bronzing, reddening of the older leaves, and with those plants that develop the abcission layer, shedding of the older leaves is common.

Willstätter (80) has shown that magnesium is a component of the chlorophyll molecule.

Sulphur

The element sulphur like magnesium cannot be classed as a micro-nutrient, but the shortage of this element results in characteristic growth manifestations which are strikingly different from those due to magnesium. The initial effects are a yellowing or

Fig. 2. Effect of magnesium deficiency on growth of tobacco. (5) Without magnesium; (6) magnesium added. Note loss of green color of lower leaves and reduction in growth in (5).

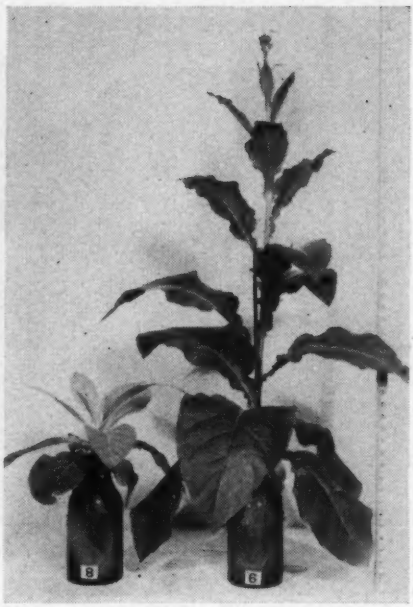

Fig. 4. Effect of sulphur on growth of tobacco. (8) Sulphur withheld; (6) sulphur supplied.

lighter green color of the younger leaves (55) on the tobacco (Fig. 3) plant. The lower leaves on such plants do not dry up as in case of the well-known nitrogen deficiency. In solution culture experiments (55), sulphur deficiency stimulated root growth with tobacco (Fig. 4).

The yellows disease of the tea bush (71) has been reported to be due to sulphur deficiency. The citrus trees

Fig. 3. Effect of sulphur on green color of tobacco. (A) Adequate sulphur supplied; (B) Sulphur withheld. Note lack in green color.

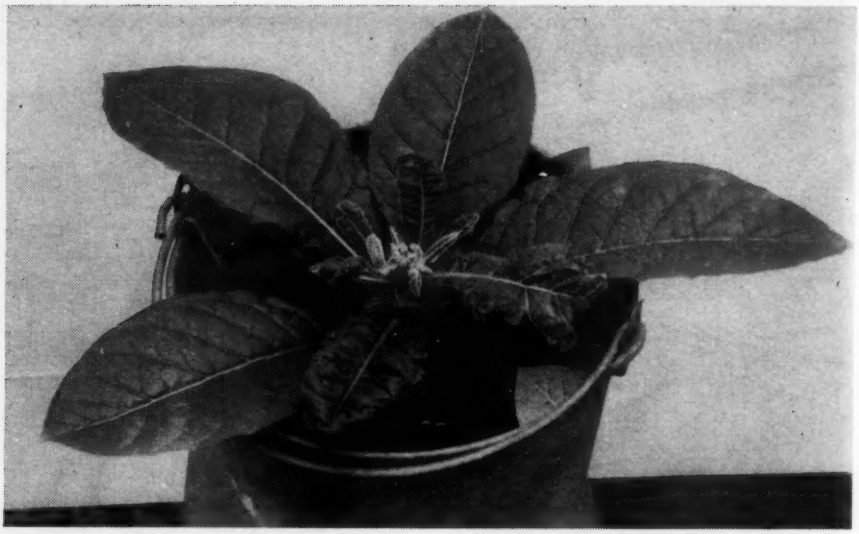

Fig. 5. Tobacco plant manifesting typical effects of calcium shortage.

including orange, lemon, and grapefruit (38) show yellowing of the younger leaves (Fig. 4) at the outset of sulphur deficiency. Most sulphur-deficient plants manifest distinctive growth effects, typically by yellowing of the younger leaves as the first symptom, later followed by yellowing of all the leaves on the plant. Sulphur is known to be a constituent of plant proteins.

Calcium

Calcium is another element not belonging to the so-called micro-element group which produces characteristic growth manifestations. However, because of the close resemblance to de-

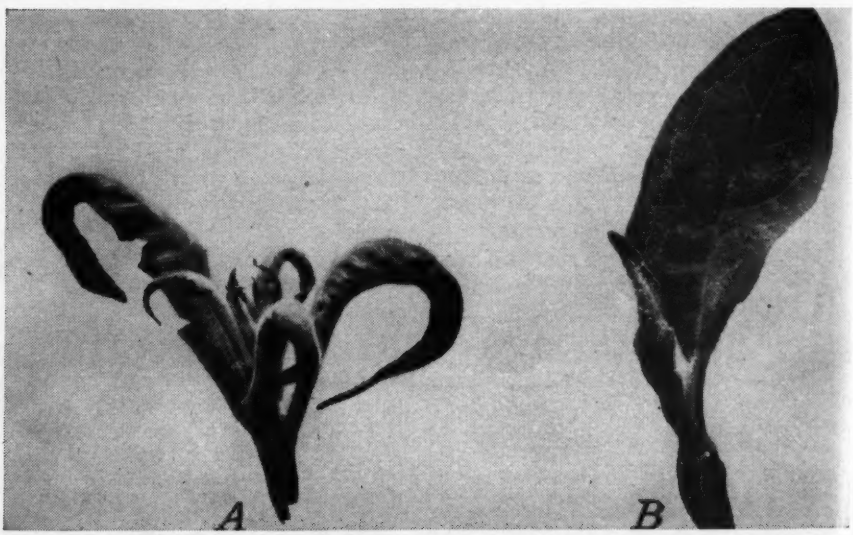

Fig. 6. Tobacco showing terminal growth effects. (A) First stage of calcium shortage as it affects the new growth; (B) early stages of growth resulting from boron deficiency.

ficiency effects which are associated with the shortage of the micro-element boron, the growth manifestations have been studied in tobacco (55, 57). There appears to be a difference in the tissues involved (55, 57) in the progressive stages of breakdown of the young leaves making up the terminal bud of the tobacco plant (Fig. 5). A characteristic hooking at the tips followed by breakdown of the leaf tissue at the tips and margins of the leaves is typical of calcium deficiency, while in contrast when boron is short, the young leaves will show breakdown at the base of the leaf (Fig. 6).

Death of the terminal growing points is the result of breakdown of the meristematic tissues. This commonly takes place in both stem and root. It is not clear that calcium is a cell wall constituent as calcium pectate, but the above-mentioned symptoms support this explanation as one of the functions of calcium. A well-recognized function of calcium is associated with antagonism to other ions. Soils which are acid and contain manganese show toxicity to this element when the calcium level is low. Magnesium toxicity and calcium deficiency often appear to be related or possibly even identical.

Boron

The French investigator Agulhon (1) appears to have published in 1910 the first paper pointing out the essential nature of boron for higher plants. This work was substantiated by Warington (76, 77) in papers published in 1923 and 1926 reporting work on the broad bean that the growth of meristematic tissue was abnormal both in the root and stem tissues when boron was deficient. Work by Brenchley and Thornton (14) published in 1925 pointed out the failure of nodule development in *Vicia faba* when boron was deficient. The relation between boron and calcium absorption and utilization was recognized by Brenchley and Warington (15) and Warington (78). Working

Fig. 7. Effects of boron shortage on growth of tobacco. (7) No boron added; (6) boron supplied.

with the tomato plant, Johnston et al (45, 46) reported death of the terminal growing point of the stem, breakdown of the conducting tissues, characteristic brittleness of the leaf petioles and the stem, and extremely poor growth and brownish unhealthy color of the roots. The effect of boron on growth of the tobacco plant in solution cultures was first reported by Swannback (72). The distinctive effects of boron deficiency on the growth of tobacco were described by McMurtrey (54) in 1929 (Fig. 7) with the most characteristic apparent effect as injury to the terminal bud development differing from that previously mentioned as characteristic for calcium deficiency. The roots of tobacco plants were poor when boron was deficient.

The first case of recognized boron deficiency under field conditions was that reported for tobacco by Kuijper (50) from Sumatra and designated as topsickness. The symptoms reported agreed with those previously described by McMurtrey (54). The control of

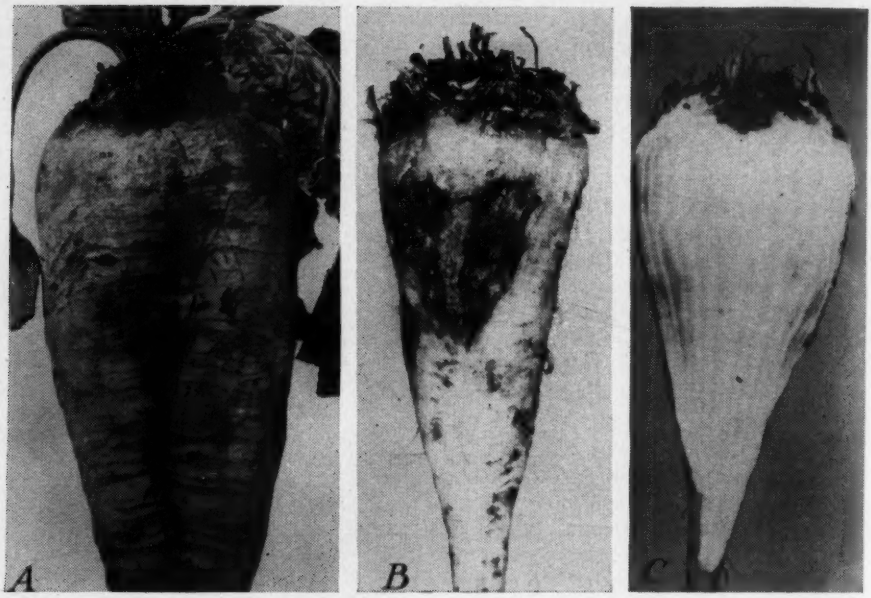

Fig. 8. Effects of boron deficiency on heart- and dry-rot of sugar beets. (A) Normal beet; (B) breakdown due to boron shortage; (C) longitudinal section of beet showing discolorations and early breakdown due to boron shortage.

heart- and dry-rot of sugar beets under field conditions by the use of boron was reported by Brandenburg (12, 13). The first instance of boron deficiency under field conditions in the United States was that on tobacco (56) in 1935. It was also reported in the same year on field-grown sugar beets in Michigan and

Fig. 9. Effects of boron excess on tobacco.

Ohio by Kotila and Coons (49) (Fig. 8). The internal cork of apples (7), boron deficiency in pears (47), internal browning of cauliflower (23), and cracked stem of celery (63) have been shown to be due to boron deficiency.

The merisematic tissue is seriously affected when boron is deficient for the growth of plants. This element has been reported (24, 25) to regulate water relations of the plasma colloids and to be involved in carbohydrate transportation and utilization.

Excessive amounts of this element often result in serious disturbances to plant growth (Fig. 9). This was forcibly brought to attention during World War I when the use of domestic potash salts which at that time contained excessive amounts of boron, caused serious losses.

Copper

The solution culture method can be used to demonstrate the effect of copper on the growth of plants. The solutions must be prepared with pure chemicals containing little or no copper and the water must be redistilled, using pyrex glass or other condensers to free the medium from this element. The plants must be grown in special containers to avoid contamination by copper compounds. Tobacco (58) grown under such conditions shows striking effects from lack of copper (Fig. 10) characterized by wilting of the upper leaves. When the seed stalk has formed, the seed head is unable to stand erect and bends as shown in Fig. 11. There is also a more or less characteristic breakdown of the older leaves (Fig. 12).

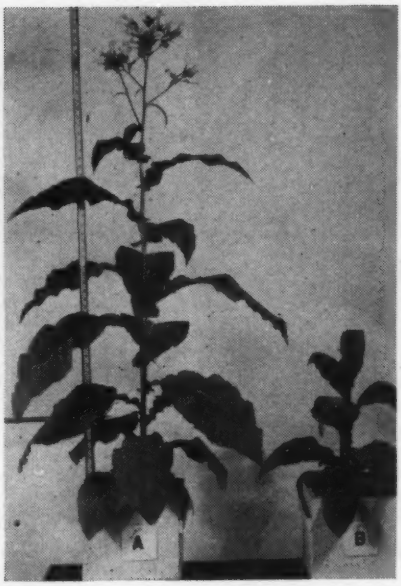

Fig. 10. Effects of copper deficiency on growth of tobacco plants.

The dieback or exanthema of citrus trees in Florida has been corrected by the use of copper compounds (29). The use of copper compounds on the

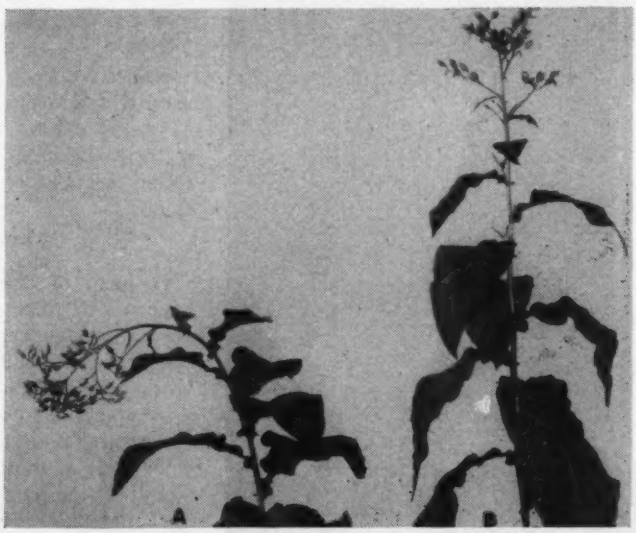

Fig. 11. Effects of copper shortage on bending of seed stalk. (A) Copper withheld; (B) copper supplied.

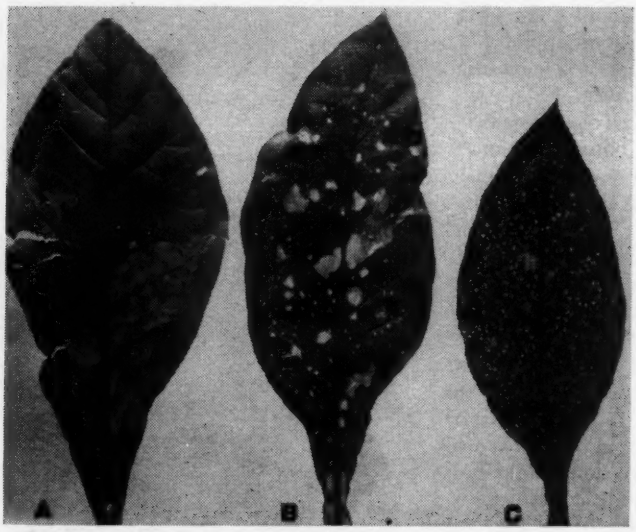

Fig. 12. Effects of copper shortage on breakdown of tobacco leaves. (A) Older leaf; (B) middle leaf; and (C) top leaf.

raw peat soils of Florida Everglades (4) has produced striking effects on plant growth. The use of copper on muck soils (48) has produced effects on onions causing increased thickness of the scales and improvement in color.

The most striking effect evident on most plants due to a lack of copper is the so-called wither-tip symptom as illustrated by the tobacco plant.

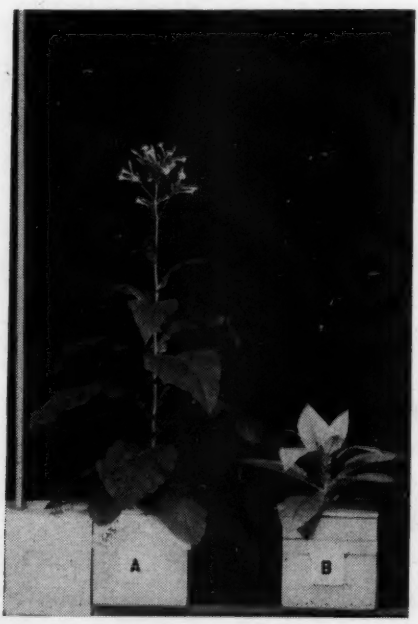

Fig. 13. Effects of iron deficiency on growth of tobacco. (A) Iron supplied; (B) iron withheld.

Iron

It has been mentioned that iron deficiency was early recognized and is typified by a characteristic chlorosis of plants. The chlorosis of pineapples in Hawaii (41, 42, 43, 44) has been shown to be due to iron deficiency induced by excess manganese in the soil. Iron chlorosis may be (35) induced by soil reaction, sometimes spoken of as lime-induced. The work of Olsen (62) in nutrient solutions has shown that reaction and phosphate ion content of the medium are important contributing factors.

Iron chlorosis has been reported on a variety of plants as illustrated by tobacco (Fig. 13). Chlorosis of the young leaves in the early stages with little or no associated necrosis characterizes this deficiency.

Manganese

A form of chlorosis in plants was reported by Maze (59) as due to manganese deficiency. The role of manganese in the nutrition of plants was studied by McHargue (52) who found (53) an etiolated condition of the young leaves and buds of plants grown with low levels of manganese.

It has been pointed out by Olsen (61) that manganese absorption is correlated with reaction of the medium, and on

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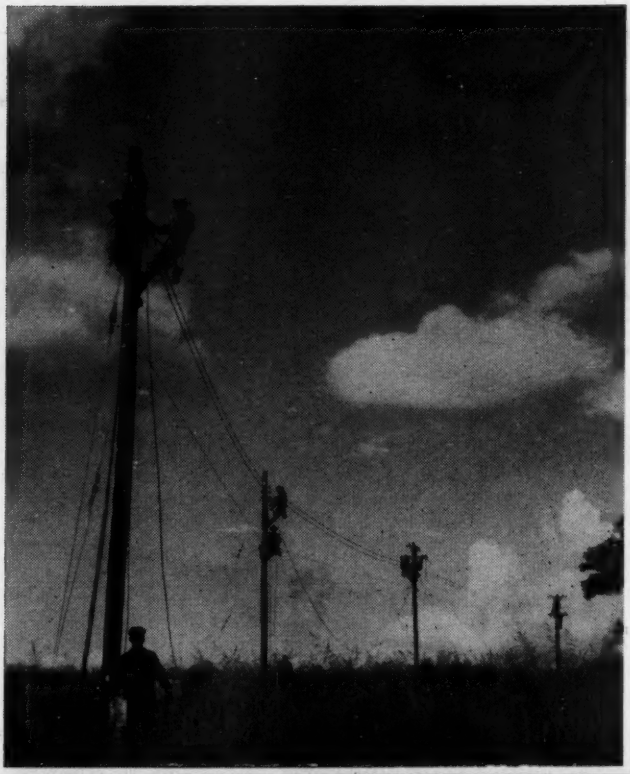
PICTORIAL

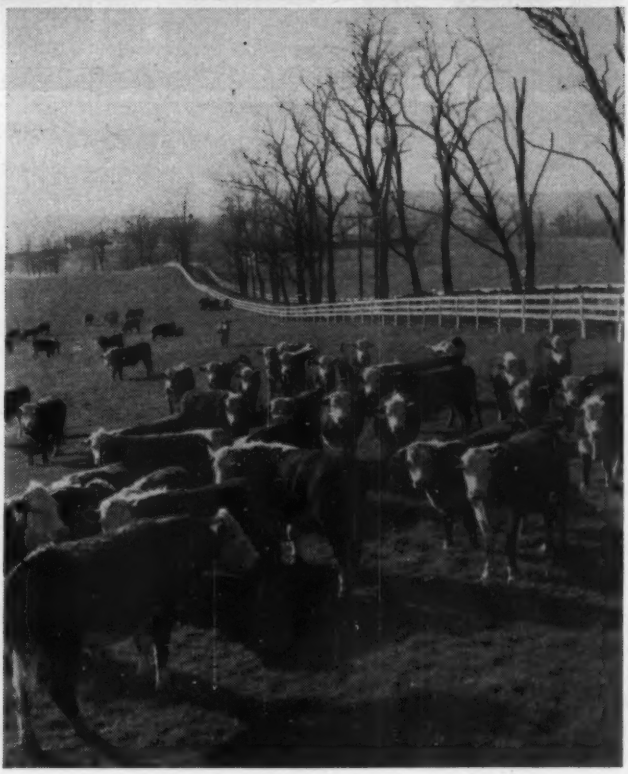
A Good Winter's Supply



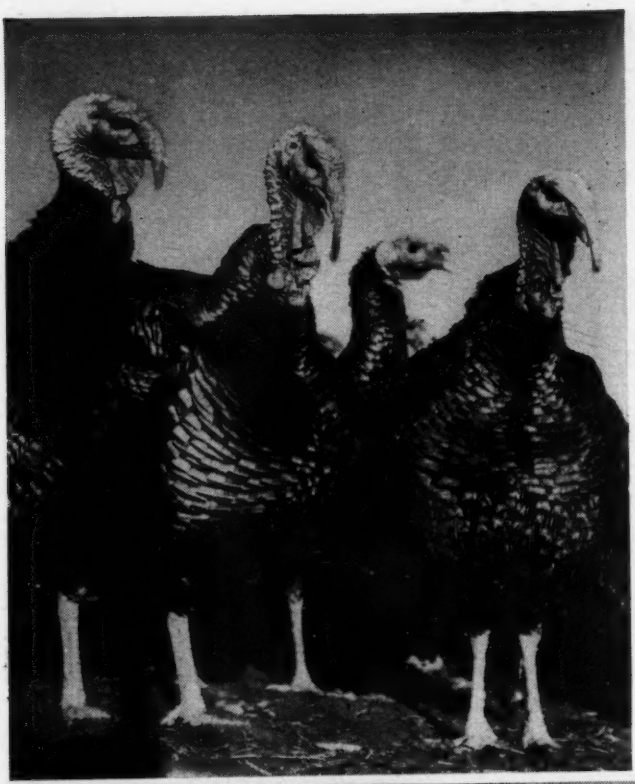
Left: Cold—but lines must be fixed.

Below: Farm near Walnut Creek, Calif.

Above: A familiar November landscape.



Right: Contented on good fall pasture.



Left: Will we be included?

Below: They were!

The Editors Talk

Our Cover Picture

Tobacco has played an important role in the agricultural economy of America. Almost every phase of our economic and social life since the settlement of Jamestown in 1607 has been enriched through the wealth created by this crop. In addition to being one of our greatest sources of Federal revenue, it is an important source of income to farmers growing it.

In 1950, according to the Bureau of Agricultural Economics, tobacco production in this country was 2,035,915,000 pounds with a value estimated to be more than a billion dollars. Taxes on the 1950 crop collected by Internal Revenue totaled $84,648,198.

Requirements of the tobacco plant for potassium are high. Growing plants manifest strikingly characteristic effects when this element is not present in adequate quantity. Regardless of the type of tobacco, the first indication of potassium deficiency is a downward rolling or cupping at the tips and margins of the lower leaves. This is followed by a typical mottling or chlorosis and then by a necrotic specking, usually in small areas in the center of the mottled tissue. The necrotic areas may later enlarge and coalesce, involving most of the leaf tissue between the veins. Dead tissue in the necrotic areas may fall out, giving a ragged appearance to the leaf. The parts of the leaf that retain their green color appear to manifest a darker green color than normal, a bluish-green shade.

Potassium deficiency symptoms first appearing on the lower leaves progress rapidly to the upper leaves. The bud leaves, however, tend to retain their normal appearance, apparently because of translocation of potassium from the older to the newer leaves. Age of the plant does not determine the manifestation of potassium deficiency, since it may be observed on young seedlings in the plantbed as well as on the larger plants in the field. Potassium shortage is accentuated by dry weather conditions.

There is considerable evidence that under field conditions, liberal potassium supply enables tobacco plants to withstand or ward off attacks of leaf-spot diseases caused by bacteria. It is possible that necrosis due to simple potassium deficiency allows the organisms causing leaf-spot diseases to gain entrance into the leaf tissue, thus hastening its breakdown. There appears to be a relationship between potassium and nitrogen in this connection, for with cigar tobacco grown under high-nitrogen conditions, it is difficult to obtain the protective action of potassium found with Maryland and flue-cured types where the nitrogen supply is purposely limited.

Tobacco when properly grown has a high acre-value. It is responsive to fertilization and will justify large applications of whatever plant food may be required for the production of quality leaf. The factors that constitute the accepted basis of quality are flavor, aroma, and burn. Of the three essential plant-food elements required for satisfactory growth, potash is regarded as the most important in determining the quality of the leaf. This value of potash

is universally reflected in the official recommendations for fertilization of the tobacco crop.

The tobacco shown in the cover illustration, courtesy Virginia Agricultural Experiment Station, is of the burley type and was grown in southwestern Virginia. In this type of tobacco, due to the thicker leaf and the conditions under which the crop usually is grown, the advanced stages of potash deficiency symptoms described in the foregoing are not so marked as in the thinner cigarette and lighter-textured types of tobacco. Due to the more intensive fertilization of tobacco in most sections, the striking symptoms that often were observed in past years are not now so commonly found. Moderate potash deficiency symptoms as in the illustration, however, are far too common and will only be corrected by following official recommendations.

Welcome

In line with the expansion of research, and particularly that taking place in agriculture, comes the need for more means of disseminating information on the results of such research into channels where it can be effectively put into use. The American Chemical Society, recognizing this need, is announcing the publication of a new journal to be called *Agricultural and Food Chemistry*. Our welcome to the new journal and our commendation to the Society for its foresightedness are to be added to the countless others which must be following the announcement.

Appearing bi-weekly beginning April 1953, the publication will cover the whole broad field of agriculture, food, and nutrition. In addition to all phases of food production and processing, the contents will deal with chemical developments designed to expand yields of crops required in the manufacture of many industrial products and articles of clothing and shelter.

"One of the most serious problems facing the world today is that of providing adequate food supplies and proper diets for the world's growing population," the announcement says. "Adequate diets in the future will depend largely on better crop yields, which in turn means better agricultural practices, including greater and more effective utilization of fertilizers, pesticides, and other chemical aids. This will be especially true where little additional farm acreage is available."

It is expected that the new journal in many respects will restore the service provided by *The Journal of Agricultural Research*, publication of which by the U. S. Department of Agriculture was discontinued a few years ago as an economy measure. The first issue will be looked for with great interest and we feel sure that it and succeeding issues will help fulfill the need which the Society has seen.

Fall Samples

Soil samples for testing taken in the fall are being emphasized as a good practice for the busy farmer planning his management program. With drier conditions than in the winter or spring, the samples will be easier to get and to handle. Possible delays in getting reports due to rush of work at the testing laboratories will not hold up his fertilizer and seeding plans. Farm advisers who are urging their constituents to take advantage of this spread of work are to be commended for this cooperation.

Season Average Prices Received by Farmers for Specified Commodities *

Crop Year	Cotton Cents per lb. Aug.-July	Tobacco Cents per lb.	Potatoes Cents per bu. July-June	Sweet Potatoes Cents per bu. July-June	Corn Cents per bu. Oct.-Sept.	Wheat Cents per bu. July-June	Hay [1] Dollars per ton July-June	Cottonseed Dollars per ton July-June	Truck Crops ....
Av. Aug. 1909–July 1914....	12.4	10.0	69.7	87.8	64.2	88.4	11.87	22.55	....
1926.....	12.5	17.9	131.4	117.4	74.5	121.7	13.24	22.04	....
1927.....	20.2	20.7	101.9	109.0	85.0	119.0	10.29	34.83	....
1928.....	18.0	20.0	53.2	118.0	84.0	99.8	11.22	34.17	....
1929.....	16.8	18.3	131.6	117.1	79.9	103.6	10.90	30.92	....
1930.....	9.5	12.8	91.2	108.1	59.8	67.1	11.06	22.04	....
1931.....	5.7	8.2	46.0	72.6	32.0	39.0	8.69	8.97	....
1932..	6.5	10.5	38.0	54.2	31.9	38.2	6.20	10.33	....
1933.....	10.2	13.0	82.4	69.4	52.2	74.4	8.09	12.88	....
1934.....	12.4	21.3	44.6	79.8	81.5	84.8	13.20	33.00	....
1935.....	11.1	18.4	59.3	70.3	65.5	83.2	7.52	30.54	....
1936.....	12.4	23.6	114.2	92.9	104.4	102.5	11.20	33.36	....
1937.....	8.4	20.4	52.9	78.0	51.8	96.2	8.74	19.51	....
1938.....	8.6	19.6	55.7	69.8	48.6	56.2	6.78	21.79	....
1939.....	9.1	15.4	69.7	73.4	56.8	69.1	7.94	21.17	....
1940.....	9.9	16.0	54.1	85.4	61.8	68.2	7.59	21.73	....
1941.....	17.0	26.4	80.8	92.2	75.1	94.4	9.70	47.65	....
1942.....	19.0	36.9	117.0	118.0	91.7	110.0	10.80	45.61	....
1943.....	19.9	40.5	131.0	206.0	112.0	136.0	14.80	52.10	....
1944.....	20.7	42.0	150.0	190.0	109.0	141.0	16.50	52.70	....
1945.....	22.5	36.6	143.0	204.0	127.0	150.0	15.10	51.10	....
1946.....	32.6	38.2	124.0	218.0	156.0	191.0	16.70	72.00	....
1947.....	31.9	38.0	162.0	217.0	216.0	229.0	17.60	85.90	....
1948.....	30.4	48.2	155.0	222.0	129.0	200.0	18.45	67.20	....
1949.....	28.6	45.9	128.0	214.0	124.0	188.0	16.50	43.40	....
1950.....	40.1	51.6	91.6	173.0	153.0	200.0	16.70	86.50	....
1951									
October.....	36.21	57.7	139.0	271.0	164.0	210.0	17.15	69.90	....
November....	41.00	50.0	174.0	280.0	162.0	219.0	18.35	72.70	....
December....	40.34	51.0	193.0	305.0	169.0	222.0	19.65	71.50	....
1952									
January.....	38.70	46.2	207.0	347.0	168.0	220.0	20.75	70.10	....
February....	37.25	33.8	205.0	357.0	166.0	218.0	20.65	67.10	....
March.....	36.72	23.5	216.0	383.0	165.0	220.0	20.35	61.50	....
April.....	37.30	15.0	231.0	416.0	168.0	218.0	20.05	60.80	....
May.....	36.08	43.5	264.0	433.0	170.0	213.0	18.65	60.80	....
June.....	38.02	44.0	310.0	436.0	173.0	206.0	17.05	61.90	....
July.....	37.02	42.0	274.0	446.0	173.0	198.0	17.25	71.00	....
August.....	37.92	48.8	278.0	410.0	173.0	204.0	19.35	69.80	....
September...	39.17	51.0	222.0	335.0	171.0	209.0	20.25	69.60	....
Index Numbers (Aug. 1909—July 1914 = 100)									
1926.....	101	179	189	134	116	138	112	98	139
1927.....	163	207	146	124	132	135	87	154	127
1928.....	145	200	76	134	131	113	95	152	154
1929.....	135	183	189	133	124	117	92	137	137
1930.....	77	128	131	123	93	76	93	98	129
1931.....	46	82	66	83	50	44	73	40	115
1932.....	52	105	55	62	50	43	52	46	102
1933.....	82	130	118	79	81	84	68	57	91
1934.....	100	213	64	91	127	96	111	146	95
1935.....	90	184	85	80	102	94	63	135	119
1936.....	100	236	164	106	163	116	94	148	104
1937.....	68	204	76	89	81	109	74	87	110
1938.....	69	196	80	79	76	64	57	97	88
1939.....	73	154	100	84	88	78	67	94	91
1940.....	80	160	78	97	96	77	64	96	111
1941.....	137	264	116	105	117	107	82	211	129
1942.....	153	369	168	134	143	124	91	202	163
1943.....	160	405	188	235	174	154	125	231	245
1944.....	167	420	214	216	170	160	139	234	212
1945.....	181	366	205	232	198	170	127	227	207
1946.....	263	382	178	248	212	209	141	319	182
1947.....	257	380	232	248	336	259	148	381	226
1948	245	482	222	253	201	226	155	298	214
1949.....	231	459	184	244	193	213	139	192	201
1950.....	323	516	131	197	238	226	141	384	185
1951									
October.....	292	577	188	309	255	238	144	310	171
November...	331	500	250	319	252	248	155	322	249
December....	325	510	277	347	263	251	166	317	331
1952									
January.....	312	462	297	395	262	249	175	311	337
February.....	300	338	294	407	259	247	174	298	217
March.....	296	235	310	436	257	249	171	273	265
April.....	301	150	331	474	262	247	169	270	308
May.....	291	435	379	493	265	240	157	270	285
June.....	307	440	445	497	269	233	144	275	250
July.....	299	420	393	508	269	224	145	315	287
August.....	306	488	399	467	269	231	163	310	229
September...	316	510	319	382	266	236	171	309	182

Wholesale Prices of Ammoniates

	Nitrate of soda bulk per unit N	Sulphate of ammonia bulk per unit N	Cottonseed meal S. E. Mills per unit N	Fish scrap, dried 11–12% ammonia, 15% bone phosphate, f.o.b. factory bulk per unit N	Tankage 11% ammonia, 15% bone phosphate, f.o.b. Chicago, bulk, per unit N	High grade ground blood, 16–17% ammonia, Chicago, bulk, per unit N
1910–14	$2.68	$2.85	$3.50	$3.53	$3.37	$3.52
1926	3.06	2.41	4.40	4.95	4.36	4.90
1927	3.01	2.26	5.07	5.87	4.32	5.70
1928	2.67	2.30	7.06	6.63	4.92	6.00
1929	2.57	2.04	5.64	5.00	4.61	5.72
1930	2.47	1.81	4.78	4.96	3.79	4.58
1931	2.34	1.46	3.10	3.95	2.11	2.46
1932	1.87	1.04	2.18	2.18	1.21	1.36
1933	1.52	1.12	2.95	2.86	2.06	2.46
1934	1.52	1.20	4.46	3.15	2.67	3.27
1935	1.47	1.15	4.59	3.10	3.06	3.65
1936	1.53	1.23	4.17	3.42	3.58	4.25
1937	1.63	1.32	4.91	4.66	4.04	4.80
1938	1.69	1.38	3.69	3.76	3.15	3.53
1939	1.69	1.35	4.02	4.41	3.87	3.90
1940	1.69	1.36	4.64	4.36	3.33	3.39
1941	1.69	1.41	5.50	5.32	3.76	4.43
1942	1.74	1.41	6.11	5.77	5.04	6.76
1943	1.75	1.42	6.30	5.77	4.86	6.62
1944	1.75	1.42	7.68	5.77	4.86	6.71
1945	1.75	1.42	7.81	5.77	4.86	6.71
1946	1.97	1.44	11.04	7.38	6.60	9.33
1947	2.50	1.60	12.72	10.66	12.63	10.46
1948	2.86	2.03	12.94	10.59	10.84	9.85
1949	3.15	2.29	10.11	13.18	10.73	10.62
1950	3.00	1.95	11.01	11.70	10.21	9.36
1951						
October	3.13	2.07	12.85	11.28	10.56	10.32
November	3.34	2.07	13.93	11.28	10.39	10.25
December	3.34	2.07	14.27	11.28	10.08	10.02
1952						
January	3.34	2.07	14.27	11.28	10.39	12.16
February	3.34	2.07	14.27	11.28	11.61	11.08
March	3.34	2.07	14.26	11.28	9.71	9.04
April	3.34	2.07	14.26	11.28	8.80	8.05
May	3.34	2.07	14.25	11.28	7.75	7.36
June	3.34	2.07	14.27	11.28	8.38	8.38
July	3.34	2.07	14.26	11.28	8.19	7.59
August	3.34	2.07	14.26	11.28	9.78	7.89
September	3.34	2.07	13.39	11.25	11.11	10.02
			Index Numbers (1910-14 = 100)			
1926	113	84	126	140	129	139
1927	112	79	145	166	128	162
1928	100	81	202	188	146	170
1929	96	72	161	142	137	162
1930	92	64	137	141	112	130
1931	88	51	89	112	63	70
1932	71	36	62	62	36	39
1933	59	39	84	81	97	71
1934	59	42	127	89	79	93
1935	57	40	131	88	91	104
1936	59	43	119	97	106	131
1937	61	46	140	132	120	122
1938	63	48	105	106	93	100
1939	63	47	115	125	115	111
1940	63	48	133	124	99	96
1941	63	49	157	151	112	126
1942	65	49	175	163	150	192
1943	65	50	180	163	144	189
1944	65	50	219	163	144	191
1945	65	50	223	163	144	191
1946	74	51	315	209	196	265
1947	93	56	363	302	374	297
1948	107	71	370	300	322	280
1949	117	80	289	373	318	302
1950	112	68	315	331	303	266
1951						
October	117	73	365	320	313	293
November	125	73	398	320	308	291
December	125	73	408	320	299	285
1952						
January	122	73	408	320	308	345
February	125	73	408	320	344	315
March	125	73	407	320	288	257
April	125	73	407	320	261	229
May	125	73	407	320	230	209
June	125	73	408	320	249	238
July	125	73	407	320	243	216
August	125	73	407	320	290	224
September	125	73	383	319	330	285

Wholesale Prices of Phosphates and Potash * *

	Superphosphate, Baltimore, per unit	Florida land pebble, 68% f.o.b. mines, bulk, per ton	Tennessee phosphate rock, 75% f.o.b. mines, bulk, per ton	Muriate of potash bulk, per unit, c.i.f. Atlantic and Gulf ports[1]	Sulphate of potash in bags, per unit, c.i.f. Atlantic and Gulf ports[1]	Sulphate of potash magnesia, per ton, c.i.f. Atlantic and Gulf ports[1]	Manure salts bulk, per unit, c.i.f. Atlantic and Gulf ports[1]
1910–14	$0.536	$3.61	$4.88	$0.714	$0.953	$24.18	$0.657
1926	.598	3.20	5.57	.596	.854	23.58	.537
1927	.525	3.09	5.50	.646	.924	25.55	.586
1928	.580	3.12	5.50	.669	.957	26.46	.607
1929	.609	3.18	5.50	.672	.962	26.59	.610
1930	.542	3.18	5.50	.681	.973	26.92	.618
1931	.485	3.18	5.50	.681	.973	26.92	.618
1932	.458	3.18	5.50	.681	.963	26.90	.618
1933	.434	3.11	5.50	.662	.864	25.10	.601
1934	.487	3.14	5.67	.486	.751	22.49	.483
1935	.492	3.30	5.69	.415	.684	21.44	.444
1936	.476	1.85	5.50	.464	.708	22.94	.505
1937	.510	1.85	5.50	.508	.757	24.70	.556
1938	.492	1.85	5.50	.523	.774	15.17	.572
1939	.478	1.90	5.50	.521	.751	24.52	.570
1940	.516	1.90	5.50	.517	.730	24.75	.573
1941	.547	1.94	5.64	.522	.780	25.55	.367
1942	.600	2.13	6.29	.522	.810	25.74	.205
1943	.631	2.00	5.93	.522	.786	25.35	.195
1944	.645	2.10	6.10	.522	.777	25.35	.195
1945	.650	2.20	6.23	.522	.777	25.35	.195
1946	.671	2.41	6.50	.508	.769	24.70	.190
1947	.746	3.05	6.60	.432	.706	18.93	.195
1948	.764	4.27	6.60	.397	.681	14.14	.195
1949	.770	3.88	6.22	.397	.703	14.14	.195
1950	.763	3.83	5.47	.371	.716	14.33	.195
1951							
October	.820	3.98	5.47	.386	.768	14.72	.193
November	.820	3.98	5.47	.386	.768	14.72	.193
December	.820	3.98	5.47	.420	.827	16.00	.210
1952							
January	.820	3.98	5.47	.420	.827	16.00	.210
February	.820	3.98	5.47	.420	.827	16.00	.210
March	.832	3.98	5.47	.420	.827	16.00	.210
April	.840	3.98	5.47	.420	.827	16.00	.210
May	.860	3.98	5.47	.420	.827	16.00	.210
June	.860	3.98	5.47	.353	.708	13.44	.176
July	.860	3.98	5.47	.386	.768	14.72	.193
August	.860	3.98	5.47	.386	.768	14.72	.193
September	.860	3.98	5.47	.389	.768	14.72	.193
			Index Numbers (1910-14 = 100)				
1926	112	88	114	83	90	98	82
1927	100	86	113	90	97	106	89
1928	108	86	113	94	100	109	92
1929	114	88	113	94	101	110	93
1930	101	88	113	95	102	111	94
1931	90	88	113	95	102	111	94
1932	85	88	113	95	101	111	94
1933	81	86	113	93	91	104	91
1934	91	87	110	68	79	93	74
1935	92	91	117	58	72	89	68
1936	89	51	113	65	74	95	77
1937	95	51	113	71	79	102	85
1938	92	51	113	73	81	104	87
1939	89	53	113	73	79	101	87
1940	96	53	113	72	77	102	87
1941	102	54	110	73	82	106	87
1942	112	59	129	73	85	106	84
1943	117	55	121	73	82	105	83
1944	120	58	125	73	82	105	83
1945	121	61	128	73	82	105	83
1946	125	67	133	71	81	102	82
1947	139	84	135	70	74	78	83
1948	143	118	135	67	72	58	83
1949	144	108	128	67	74	58	83
1950	142	106	112	68	75	59	83
1951							
October	153	110	112	70	81	61	82
November	153	110	112	70	81	61	82
December	153	110	112	75	87	66	85
1952							
January	153	110	112	75	87	66	85
February	153	110	112	75	87	66	85
March	155	110	112	75	87	66	85
April	157	110	112	75	87	66	85
May	160	110	112	75	87	66	85
June	160	110	112	65	74	56	80
July	160	110	112	70	81	61	82
August	160	110	112	70	81	61	82
September	160	110	112	70	81	61	82

Combined Index Numbers of Prices of Fertilizer Materials, Farm Products and All Commodities

	Farm prices*	Prices paid by farmers for commodities bought*	Wholesale prices of all commodities†	Fertilizer material‡	Chemical ammoniates	Organic ammoniates	Superphosphate	Potash**
1926.....	146	150	146	119	94	135	112	86
1927.....	141	148	139	116	89	150	100	94
1928.....	149	152	141	121	87	177	108	97
1929.....	148	150	139	114	79	146	114	97
1930.....	125	140	126	105	72	131	101	99
1931.....	87	119	107	83	62	83	90	99
1932.....	65	102	95	71	46	48	85	99
1933.....	70	104	96	70	45	71	81	95
1934.....	90	118	109	72	47	90	91	72
1935.....	109	123	117	70	45	97	92	63
1936.....	114	123	118	73	47	107	89	69
1937.....	122	130	126	81	50	129	95	75
1938.....	97	122	115	78	52	101	92	77
1939.....	95	121	112	79	51	119	89	77
1940.....	100	122	115	80	52	114	96	77
1941.....	123	130	127	86	56	130	102	77
1942.....	158	149	144	93	57	161	112	77
1943.....	192	165	151	94	57	160	117	77
1944.....	196	174	152	96	57	174	120	76
1945.....	206	180	154	97	57	175	121	76
1946.....	234	197	177	107	62	240	125	75
1947.....	275	231	222	130	74	362	139	72
1948.....	285	250	241	134	89	314	143	70
1949.....	249	240	226	137	99	319	144	70
1950.....	256	246	236	132	89	314	142	72
1951								
October...	296	272	259	140	94	335	153	73
November.	301	274	259	143	98	343	153	73
December..	305	273	258	144	98	342	153	78
1952								
January...	300	275	258	144	98	347	153	78
February..	289	276	255	146	98	365	153	78
March....	288	275	251	144	98	336	155	78
April.....	290	276	251	142	98	322	157	78
May.....	293	276	252	142	98	306	160	78
June.....	292	273	250	141	98	316	160	69
July.....	295	273	250	141	98	313	160	73
August....	295	274	252	144	98	337	160	73
September.	288	271	250	145	98	349	160	74

* U. S. D. A. figures, revised January 1950. Beginning January 1946 farm prices and index numbers of specific farm products revised from a calendar year to a crop-year basis. Truck crops index adjusted to the 1924 level of the all-commodity index.

† Department of Labor index converted to 1910-14 base.

‡The Index numbers of prices of fertilizer materials are based on original study made by the Department of Agricultural Economics and Farm Management, Cornell University, Ithaca, New York. These indexes are complete since 1897. The series was revised and reweighted as of March 1940 and November 1942.

[1] **Beginning July 1949, baled hay prices reduced by $4.75 a ton to be comparable to loose hay prices previously quoted.**

[2] **All potash salts now quoted F.O.B. mines only; manure salts since June 1941, other carriers since June 1947.**

** **The weighted average of prices actually paid for potash is lower than the annual average because since 1926 over 90% of the potash used in agriculture has been contracted for during the discount period. The maximum discount is now 16%. Applied to muriate of potash, a price slightly above $.353 per unit K_2O thus more nearly approximates the annual average than do prices based on arithmetical averages of monthly quotations.**

REVIEWS

This section contains a short review of some of the most practical and important bulletins, and lists all recent publications of the United States Department of Agriculture, the State Experiment Stations, and Canada, relating to Fertilizers, Soils, Crops, and Economics. A file of this department of BETTER CROPS WITH PLANT FOOD would provide a complete index covering all publications from these sources on the particular subjects named.

Fertilizers

"Fertilizer Sales, by Grades, 1951-52 Season," Dept. of Agr., Office of the Agr. Stat., Montgomery, Ala., Aug. 14, 1952.

"Celery Fertilizer Trials, 1948—1949—1950—1951—Summary," Ext. Serv., Univ. of Calif., Berkeley, Calif., Veg. Crops Mimeo. No. 55, May 1952, J. P. Underhill, O. A. Lorenz, and M. P. Zobel.

"Substitutes for Stable Manure in Commercial Vegetable Farming," Agr. Exp. Sta., Univ. of Conn., New Haven, Conn., Bul. 560, July 1952, H. G. M. Jacobson.

"Laws, Rules and Regulations Governing the Manufacture, Sale and Inspection of Fertilizer, Fertilizer Materials and Cotton Seed Meal in the State of Georgia," Dept. of Agr., Atlanta, Ga., July 1, 1952.

"Fertilizer Recommendations for Idaho Soils," Ext. Serv., Univ. of Ida., Moscow, Ida., Ext. Cir. No. 120, Feb. 1952, V. T. Smith and G. O. Baker.

"Tonnage of Commercial Fertilizers Reported by Manufacturers as Sold in Kansas in the Spring of 1952, by Counties," Control Div., Dept. of Agr., Topeka, Kans., Sept. 4, 1952.

"Fertilizing Burley Tobacco," Ext. Serv., Univ. of Ky., Lexington, Ky., Cir. 490, Jan. 1952, C. E. Bortner, P. E. Karraker, and R. A. Hunt.

"Commercial Fertilizers in Kentucky, 1951," Agr. Exp. Sta., Univ. of Ky., Lexington, Ky., Reg. Bul. 96, Feb. 1952.

"Anhydrous Ammonia Equipment," Agr. Exp. Sta., La. State Univ., Baton Rouge, La., Bul. No. 462, Feb. 1952, H. T. Barr.

"Official Report Maryland Inspection and Regulatory Service, Feed, Fertilizer and Lime Issue," Univ. of Md., College Park, Md., Issue No. 223, Aug. 1952.

"Fall Versus Spring Fertilizer Application—A Progress Report," Div. of Soils, Univ. of Minn., St. Paul, Minn., Soil Series No. 35, July 1952, C. F. Halsey and J. M. MacGregor.

"Commercial Fertilizer Results with Winter Wheat and Rye 1952," Agr. Exp. Sta., Univ. of Nebr., Lincoln, Nebr., Outstate Testing Cir. 23, Aug. 1952, G. W. Lowrey, R. A. Olson, A. F. Dreier, and P. L. Ehlers.

"The Effect of Fertilizers on Yield and Botanical Composition of an Irrigated Pasture Mixture," Agr. Exp. Sta., N. Mex. A & M College, State College, N. Mex., Press Bul. 1068, Apr. 1952, A. D. Dotzenko and M. L. Wilson.

Soils

"Kendall County Soils," Agr. Exp. Sta., Univ. of Ill., Urbana, Ill., Soil Rpt. 75, Mar. 1952, H. L. Wascher and R. T. Odell.

"Farm Ponds," Ext. Serv., Purdue Univ., Lafayette, Ind., Bul. 369, Mar. 1952, G. A. Karstens.

"The Use of Gypsum in Soils," Agr. Exp. Sta., N. Mex. A & M College, State College, N. Mex., Press Bul. 1070, May 1952, H. E. Dregne and C. W. Chang.

"Emphasis on Conservation," Agr. Exp. Sta., State College of Wash., Pullman, Wash., Sta. Cir. No. 186, Mar. 1952, E. C. Johnson.

Crops

"Seventy-sixth Annual Report of the Ontario Agricultural College and Experimental Farm 1951," Dept. of Agr., Ottawa, Ont., Can.

"Thirty-first Annual Report of the Canadian Plant Disease Survey 1951," Science Serv., Dept. of Agr., Ottawa, Ont., Can., Aug. 21, 1952, I. L. Conners, D. B. O. Savile.

"Azalea Culture," Agr. Exp. Sta., Univ. of Fla., Gainesville, Fla., Press Bul. 658, Apr. 1952, R. J. Wilmot and R. D. Dickey.

"Tifton 57 Bermuda Grass for Lawns, Athletic Fields, and Parks," Coastal Plain Exp. Sta., Tifton, Ga., Mimeo. Paper No. 78, May 1952, G. W. Burton and B. P. Robinson.

"Irrigated Pastures for Hawaii," Ext. Serv., Univ. of Hawaii, Honolulu, Hawaii, Bul. 56, July 1952, E. Y. Hosaka and N. K. Carlson.

"How to Plant your Trees," Ext. Serv., Univ. of Ida., Moscow, Ida., Cir. 119, Dec. 1951, V. H. Burlison and F. H. Pitkin.

"Roses," Ext. Serv., Purdue Univ., Lafayette, Ind., Bul. 368, Mar. 1952, E. R. Honeywell.

"Tulips for the Amateur," Ext. Serv., Pur-

due Univ., Lafayette, Ind., Bul. 372, May 1952, C. E. Hoxsie.

"Iowa Corn Yield Test, 1951," Agr. Exp. Sta., Iowa State College, Ames, Iowa, Bul. P112, Feb. 1952, J. L. Robinson and C. D. Hutchcroft.

"Kenbar Winter Barley," Ext. Serv., Univ. of Ky., Lexington, Ky., Cir. 493, Feb. 1952, D. A. Reid.

"Research in Agr." Agr. Exp. Sta., La. State Univ., Baton Rouge, La., Ann. Rpt. 1950-51.

"Small Grain Variety Trials 1946-50," Agr. Exp. Sta., Univ. of Me., Orono, Me., Bul. 498, Mar. 1952, C. H. Moran and S. C. Junkins.

"Orland, Monmouth and Maine 55 Strawberries," Agr. Exp. Sta., Univ. of Me., Orono, Me., Misc. Pub. 620, Mar. 1952, R. M. Bailey and E. F. Murphy.

"Maintaining Red Clover Stands," Ext. Serv., Univ. of Md., College Park, Md., Fact Sheet 46, Mar. 1952, A. O. Kuhn and R. J. Allen, Jr.

"The Home Lawn," Ext. Serv., Univ. of Minn., St. Paul, Minn., Fldr. 165, Apr. 1952, L. C. Snyder.

"B-400—A New, Early Variety of Winter Barley for Missouri," Agr. Exp. Sta., Univ. of Mo., Columbia, Mo., Bul. 569, Feb. 1952, J. M. Poehlman.

"64th Annual Report. Agricultural Experiment Station, 1951," Agr. Exp. Sta., Univ. of Nebr., Lincoln, Nebr., May 1951.

"65th Annual Report of the Nebraska Agricultural Experiment Station," Agr. Exp. Sta., Univ. of Nebr., Lincoln, Nebr., Jan. 1952.

"Production Practices for Spring Small Grains," Agr. Exp. Sta., Univ. of Nebr., Lincoln, Nebr., Bul. 406, Dec. 1951, T. A. Kiesselbach and W. E. Lyness.

"Oats in Nebraska," Agr. Exp. Sta., Univ. of Nebr., Lincoln, Nebr., Bul. 408, Dec. 1951, L. P. Reitz.

"Nebraska Varietal Tests of Fall-Sown Small Grains, 1952, Winter Wheat—Winter Barley—Rye," Agr. Exp. Sta., Univ. of Nebr., Lincoln, Nebr., Outstate Testing Cir. 22, Aug. 1952, A. F. Dreier, V. A. Johnson, and P. L. Ehlers.

"Planting and Care of Fruit Trees in the Home Garden," Ext. Serv., Rutgers Univ., New Brunswick, N. J., Leaf. 84, June 1952, E. G. Christ and A. J. Farley.

"Fifty Small Trees for New Jersey Home Grounds," Ext. Serv., Rutgers Univ., New Brunswick, N. J., Leaf. 86, July 1952, R. B. Clark and R. P. Korbobo.

"Research for New Mexico Agriculture," Agr. Exp. Sta., N. Mex. A & M College, State College, N. Mex., 61 Ann. Rpt. 1949-50.

"62nd Annual Report for 1950-51," Agr. Exp. Sta., N. Mex. A & M College, State College, N. Mex.

"64th Annual Report of the New York State College of Agriculture at Cornell University & the Cornell University Agricultural Experiment Station 1951," Agr. Exp. Sta., Cornell Univ., Ithaca, N. Y.

"Yield, Tuber Set, and Quality of Potatoes, Effect of Irrigation, Date of Planting, and Straw Mulch on Several Varieties in Upstate New York 1948-1951," Agr. Exp. Sta., Cornell Univ., Ithaca, N. Y., Bul. 876, Apr. 1952, A. J. Pratt, J. Lamb, Jr., J. D. Wright, and G. Bradley.

"Accumulation of Radioisotopes in Corn Leaves," Agr. Exp. Sta., Univ. of Ohio, Wooster, Ohio, Res. Bul. 723, Aug. 1952, J. D. Sayre.

"Wheat Varieties for Oklahoma," Ext. Serv., Okla. A & M College, Stillwater, Okla., Cir. 488, R. Pierson and W. Chaffin.

"New Horizons—Annual Report for 1951," Ext. Serv., Pa. State College, State College, Pa.

"Management of Grasslands in the Northeastern States," Agr. Exp. Sta., Pa. State College, State College, Pa., Bul. 554, July 1952, V. G. Sprague, R. R. Robinson, and R. J. Garber.

"Five Legume-Grass Associations for Silage and Aftermath Grazing for Dairy Cows," Agr. Exp. Sta., Pa. State College, State College, Pa., Bul. 555, Aug. 1952, V. G. Sprague, P. S. Williams, C. B. Knodt, E. M. Kesler, and A. L. Haskins.

"Performance of Varieties of Grass and Legume Species in Pennsylvania in 1950 and 1951 and Forage Crop Variety Recommendations," Agr. Exp. Sta., Pa. State College, State College, Pa., P. R. No. 71, May 1952, H. L. Carnahan and H. R. Fortmann.

"Natural Growth Zones in Pennsylvania in Relation to Varietal Testing of Douglas Fir," Agr. Exp. Sta., Pa. State College, State College, Pa., P. R. No. 81, July 1952, W. C. Bramble and W. R. Byrnes.

"Sixty-third Annual Report of the South Carolina Experiment Station," Agr. Exp. Sta., Clemson College, Clemson, S. C., Dec. 1951.

. . "Sixty-third Annual Report of the Tennessee Agricultural Experiment Station," Agr. Exp. Sta., Univ. of Tenn., Knoxville, Tenn.

"Extra Dollars for Tennessee from Agricultural Research," Agr. Exp. Sta., Univ. of Tenn., Knoxville, Tenn., Bul. 225, June, 1952.

"Wheat Production in the Panhandle of Texas," Agr. Exp. Sta., Tex. A & M College, College Station, Tex., Bul. 750, June 1952, K. B. Porter, I. M. Atkins, and C. J. Whitfield.

"Yield of Crops Grown for Forage at Mt. Pleasant, 1950-51," Agr. Exp. Sta., Tex. A & M College, College Station, Tex., P. R. 1453, Apr. 8, 1952, M. Buckingham and R. C. Potts.

"Trials with Castor Beans in Texas, 1951," Agr. Exp. Sta., Tex. A & M College, College Station, Tex., P. R. 1455, Apr. 19, 1952, J. R. Quinby, D. L. Van Horn, and L. E. Brooks.

"Cool Season Grasses for North-Central Texas," Agr. Exp. Sta., Tex. A & M College, College Station, Tex., P. R. 1456, May 1, 1952, D. I. Dudley and E. C. Holt.

"The Influence of Spacing and Fertilizer on Plant Size and Shape, Boll Production and

Fiber Yield of Cotton Grown on Houston Black Clay at Temple, 1951," Agr. Exp. Sta., Tex. A & M College, College Station, Tex., P. R. 1457, May 1, 1952, R. J. Hervey, F. L. Fisher, and J. R. Johnston.

"Corn Production at Kirbyville and Cleveland, 1950-51," Agr. Exp. Sta., Tex. A & M College, College Station, Tex., P. R. 1459, May 1, 1952, E. D. Cook and R. P. Bates.

"Plants in the Home," Ext. Serv., Univ. of Wis., Madison, Wis., Cir. 406, Oct. 1951, J. G. Moore.

"Oats," Ext. Serv., Univ. of Wis., Madison, Wis., Cir. 418, Mar. 1952, H. L. Shands and D. C. Arny.

"Safeguarding New Seedings," Ext. Serv., Univ. of Wis., Madison, Wis., Cir. 300, Apr. 1940, (Rev. Jan. 1952), H. L. Ahlgren and L. F. Graber.

Economics

"Production Efficiency on New England Dairy Farms, 1. A Preliminary Appraisal of Cost Reduction Opportunities," Agr. Exp. Sta., Univ. of Conn., Storrs, Conn., Bul. 283, Jan. 1952, I. F. Fellows, G. E. Frick, and S. B. Weeks.

"Progress Report on the Management and Utilization of Feed Production Systems, Georgia Mountain Experiment Station," Agr. Exp. Sta., Univ. of Ga., Experiment, Ga., Press Bul. 639, Aug. 1952, O. L. Brooks and W. H. McKinney.

"1951 Statistics of Diversified Agriculture in Hawaii," Ext. Serv., Univ. of Hawaii, Honolulu, Hawaii, Agr. Econ. Rpt. No. 11, Apr. 1952.

"How to Finance a Farmers' Cooperative," Agr. Ext. Cir. No. 324; "How Does a Farmers' Marketing Cooperative Pay its Member-Patrons," Agr. Ext. Cir. No. 325; "There's More than One Kind of Farmers' Cooperative," Agr. Ext. Cir. No. 326; "Farmers' Cooperatives Versus Other Methods of Doing Business," Agr. Ext. Cir. No. 327; "Marketing Contracts for Farmers' Cooperatives," Agr. Ext. Cir. No. 328; "Purchasing Cooperatives for Hawaii's Farmers," Agr. Ext. Cir. No. 329; "The Revolving Fund Method of Raising Capital for Farmers' Cooperatives," Agr. Ext. Cir. No. 331; Ext. Serv., Univ. of Hawaii, Honolulu, Hawaii, June 1952, I. Rust.

"How Farmers Make Pasture Plans to Meet the Uncertainty of Weather," Agr. Exp. Sta., Univ. of Ky., Lexington, Ky., Bul. 575, Dec. 1951, E. J. Nesius.

"Burley Tobacco Control Programs—Their Over-All Effect on Production and Prices, 1933-50," Agr. Exp. Sta., Univ. of Ky., Lexington, Ky., Bul. 580, Feb. 1952, G. L. Johnson.

"Operating Policies and Practices of Cooperative Purchasing Associations in Mississippi," Agr. Exp. Sta., Miss. State College, State College, Miss., Bul. 491, June 1952, L. P. Jenkins.

"Systems of Farming in Irrigation Districts in the Republican River Valley," Agr. Exp. Sta., Univ. of Nebr., Lincoln, Nebr., Bul. 404, Oct. 1951, T. S. Thorfinnson, A. W. Epp, and W. H. Pine.

"Oregon's Specialty, Horticultural Crops, 1936-1949," Ext. Serv., Oreg. State College, Corvallis, Oreg., Ext. Bul. 724, Mar. 1952, F. H. Dahl.

"Cotton Statistics—South Carolina and Selected Areas," Agr. Exp. Sta., Clemson College, Clemson, S. C., Cir. 82, Dec. 1951, C. D. Evans.

"Virginia Farm Statistics," Dept. of Agr., Richmond, Va., Bul. No. 16, 1952.

"Washington State Annual Crop Report 1951," Dept. of Agr., Bur. of Agr. Econ., Seattle, Wash., E. C. Wilcox, R. P. Small, H. A. Swedlund, B. M. Graham, and R. A. McGregor.

"The Balance Sheet of Agriculture, 1952," USDA, Bur. of Agr. Econ., Wash. D. C., Agr. Inf. Bul. No. 90, July 1952.

"1952 Indicated Acreages and Production with Goal Comparisons," USDA, Bur. of Agr. Econ., Wash. D. C., July 11, 1952.

"Changes in Dairy Farming in the Northeast, 1930-51," USDA, Bur. of Agr. Econ., Wash. D. C., Agr. Inf. Bul. No. 86, June 1952, H. C. Fowler.

A visitor, calling at Pat's house, noted on a center table under a glass dome, a brick upon which lay a faded rose.

"Why do you cherish that common brick and the faded rose?" he asked.

"Shure," replied Pat, "there's certain memories attached to them. Do you see this big dent in me head? Well, it was made by that brick."

"But the rose?"

"The rose is off the grave of the man who threw the brick."

A farm hand, a bachelor around 55, inquired of his employer if he could borrow his automobile on a certain day, one month away.

"Sure, I guess so," the employer answered. "What's going on?"

"I'm gettin' married on that day," said the farm hand.

"Fine!", the farmer said. "Who's the lucky girl?"

"Well, I ain't picked her out yit," the bachelor confessed. "I wanted to be sure of gettin' the car first."

The Nutrition of Muck Crops . . .

(*From page* 12)

Application of salt will generally give paying increases in yield of the crops in Groups 3 and 4. An initial application of 500 to 1,000 pounds per acre is advisable for the four members of the beet family. Generally 500 pounds per acre are sufficient for celery but on fields on which celery is grown continuously, it may be necessary to reduce the annual application to 250 pounds if the heavier application causes the celery to become too brittle. For crops in Group 3 an application of 150 to 250 pounds per acre is sufficient, while the sodium present as an impurity in the fertilizer applied is likely to satisfy the needs of the crops in Group 2.

Magnesium. Although ordinarily classed as a major element, the effective use of magnesium on muck soil makes it advisable to group it with the minor elements in this discussion. Magnesium deficiency was first discovered in Michigan in 1946 on green celery and, to date, celery is the only crop showing definite deficiency symptoms. The deficiency pattern appears as a yellowing and mottling of the outer, older leaves and is much more apparent on certain green varieties than on a few green and all yellow varieties.

Most celery varieties will be improved in both appearance and eating quality by the application of magnesium sulfate. Canadian growers have shown that at least 7 pounds in 100 gallons of water, applied as a spray at regular intervals during the season, are far more effective than any amount applied to the muck. Studies at the Michigan Muck Experimental Farm confirm the Canadian trials and show that 10 pounds of magnesium sulfate per 100 gallons of spray are not too much and must be applied in regular sprayings throughout growth.

Discussion

Attempt has been made in the foregoing pages to clarify in the grower's mind the proper nutrition of crops produced on organic soils. Not so many years ago, the application of potash, along with phosphate for most crops, was considered as sufficient for

TABLE VI.—COMPARATIVE RESPONSE OF SEVERAL CROPS TO SODIUM, APPLIED AS COMMON SALT ON MUCK SOIL

No.	Response when potash supply is insufficient		Response when potash supply is ample	
	1. None to very slight	2. Slight to medium	3. Slight to medium	4. Large
1	beans	asparagus	cabbage	celery
2	corn	barley	celeriac	mangels
3	lettuce	broccoli	kale	sugar beets
4	mint	brussels sprouts	kohlrabi	swiss chard
5	onions	carrots	peas	table beets
6	parsley	millet	radishes	turnips
7	parsnips	oats	rape	
8	potatoes	rutabagas	wheat	
9	spinach	tomatoes		
10	squash	vetch		

the production of good crop yields on muck. Now we know that under many conditions, nitrogen, applied at the proper time or under abnormal climatic conditions, may double or even triple the yield of the crop.

Even with these three major elements the fertilizer problem was not such a complex one. With the addition of the possible need of five minor elements and a possibility that another major one, magnesium, may be needed for a few crops on some of the older muck soils, the whole matter of a balanced fertilizer program becomes very complicated. No farmer of organic soil can afford not to fertilize. In fact, the results of crop production on organic soil without mineral fertilization is Mother Nature's best answer to the advocates of the so-called "organic" farming.

Every muck farmer should be a thorough student in his line of farming. So important may be the need of a small amount of a certain plant-food element that its addition or omission may make the difference on his muck between a good crop and a failure. In the event of a question regarding a given procedure, the County Agricultural Agent, the Agricultural College, and the Soils Specialists at the College stand ready to give advice. It is a notable fact in Michigan that the Muck Farmers' Association, now in its 34th year, has among its members attending its educational meetings each year a large proportion of the successful muck farmers of the State.

Science and the Cow . . .

(*From page* 18)

off on a good level of milk production and would probably be found to be quite economical.

Figure 4 represents the dairy program needed by a producer-distributor who needs a fairly constant supply of milk throughout the year. This system is the least likely to include permanent pastures to any great extent in the total feed supply. At the same time it provides the greatest advantage for the use of temporary forages. Of the three systems, the need for a constant supply of high-quality forage is best illustrated in this one. Perhaps the best use of permanent forages can be made by harvesting them as hay for feeding during the peak periods of the temporary forages and as a source of grazing between the winter and summer temporary pastures. It should be noted that the system requires the maintenance of more cows than the straight production of Grade A milk since an even flow of milk is needed.

Having now considered the use of the cow in grassland farming along with the major problems encountered and systems involved, it would seem advisable to conclude with a few general statements. It should be remembered that while the problems have been discussed in terms of conditions existing in the Piedmont region of the Southeast, many of the same problems exist in all sections. Regardless of the theoretical advantages or disadvantages of any system of dairying, farmers can be expected to vary widely the extent to which they use any one. In general, good dairymen have tried more than one system and have found the one that best meets their needs and wants. It remains, therefore, the duty of the worker in grassland farming to search for methods to aid the dairyman to improve his system according to his needs and desires and not to attempt to sell him some particular system just because it happens to be the special product being sold at the time. Whether or not a farmer can use a certain system of grassland production depends upon so many factors that no general rule can be expected to apply over a wide area.

Deficiencies of Secondary . . .

(*From page* 26)

acid soils with a high content of this element, manganese toxicity is likely to occur. When the soil is low in manganese and if it is neutral or alkaline in reaction, a shortage of available manganese for plant growth may take place.

The effect of manganese on the growth of tomato plants on calcareous soils in Florida described by Schreiner and Dawson (65) was one of the first instances where this element was reported to be deficient under field conditions. A retarded growth, failure to blossom, and a typical chlorosis of the younger leaves with necrotic spotting were evident on the affected tomato plants. The same year, 1927, Carne (16) published his findings on the grey speck disease of oats. The first seedling leaves of the affected oat plants were normal green, but the later-developed leaves were yellowish in color and showed necrotic spotting. Much these same symptoms were reported by Samuel and Piper (64) and Davies and Jones (22). Another worker, namely Gerretsen (34), has reported that certain organisms were associated with manganese deficiency resulting in grey speck disease of oats.

The disease of sugar cane known as pahala blight has been correlated experimentally and analytically by Lee and McHargue (51) with manganese deficiency. A chlorosis of snap beans which first affects the young leaves with each new leaf manifesting more intense chlorosis followed by necrosis and shedding of the leaves and finally by death of the plant has been reported (73) from Florida.

Chlorosis distinctive of manganese deficiency is evident on young leaves of tobacco (55, 58) and typical of most plants wherein each new leaf manifests more intense chlorosis followed by

Fig. 14. Tobacco leaves (1) Iron chlorosis; (2) normal leaf; (3) chlorosis and necrosis; typical of manganese deficiency.

Fig. 15. Effects of manganese shortage on growth of tobacco. (1) Manganese supplied; (2) manganese withheld.

necrosis (Fig. 14). The reticulate chlorosis follows out in detail the smallest veins of the leaf. The color of the veins tends to remain green with the tissue between the veins varying from light green to almost white. The chlorosis may even involve the veins in extreme cases with necrosis as small dead areas which coalesce and are scattered over the entire leaf. These dead areas may fall out producing a ragged or torn leaf (57) (Fig. 15).

The exact functions of manganese in plant growth are not known.

Molybdenum

The necessity for molybdenum for nitrogen fixation by azotobacter was first pointed out by Bortels (11) in 1930. It appeared to be essential for the assimilation of gaseous nitrogen. Steinberg (68) reported in 1936 in work with *Aspergillus niger* that the response from molybdenum was more striking when nitrate was the source of nitrogen than when ammonium salts were used.

The importance of traces of molybdenum for higher plants was reported in 1939 (6) by Arnon and Stout for tomatoes grown in solution cultures.

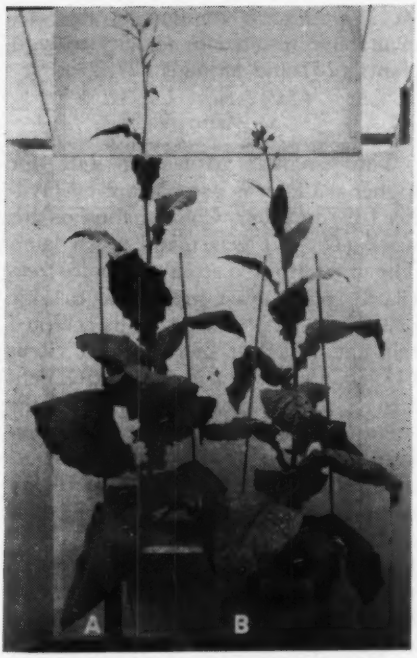


Fig. 16. Effects of molybdenum deficiency on growth of tobacco plants. (A) Molybdenum added; (B) molybdenum withheld.

There was a more or less characteristic mottling of the lower leaves followed by necrosis in the later stages of growth resulting in involutions of the leaf lamina. The fruit set was poor because of blossom abscission.

The effect of molybdenum on growth of the tobacco plant from cultures grown by my associate, Dr. R. A. Steinberg, working in the Division of Tobacco, Medicinal, and Special Crops at the Plant Industry Station, Beltsville, Maryland, will serve to illustrate growth manifestations (Fig. 16) when molybdenum is deficient. The symptoms shown are essentially the same as those indicated above on the tomato plant. The lower leaves of the tobacco plant show a characteristic chlorosis followed by necrosis and crinkling or involutions of the leaf lamina. The production of seed is reduced due to shedding of the flower buds.

Molybdenum has been shown to give responses on numerous field soils (5, 30, 74) and with a variety of crops (31,

40, 75). Excess amounts of this element have resulted in toxicity to both plants (26) and animals (27, 28).

Zinc

The essential nature of zinc for higher plants was pointed out by Javillier (39) in 1908. Confirmation of this work (66, 67) was made much later. The mysterious disease of pecan trees (2, 3) was shown to be due to zinc deficiency. It is now generally accepted that the little-leaf or rosette of citrus (17, 18, 19, 20, 21) is due to zinc deficiency. A characteristic bronzing of the leaves of the tung nut tree (60) has been corrected by additions of zinc. The white bud disease (8, 9, 10) of corn in Florida has been controlled by additions of zinc sulphate. The older leaves first show yellow streaks followed rapidly by necrosis. This condition may become so extreme that the young leaves unfolding in the bud are white to light yellow in color.

The tobacco plant (58) manifesting symptoms of zinc deficiency first shows a faint chlorosis of the lower or older leaves at the leaf tips, along the margins and between the veins. This is rapidly followed by necrosis (Fig. 17) which may occur as small areas at first and later may enlarge and involve the veins and entire leaf.

Fig. 17. Effects of zinc shortage on growth of tobacco.

It appears to be characteristic of plants suffering from zinc deficiency that there is more or less chlorosis of the older leaves followed by necrosis and sometimes shedding of the leaves.

Probable Causes of Symptom Manifestations

Decreased growth characterizes a deficiency of all essential nutrient elements and may result in failure of plant development when shortages become acute in the early stages of growth. Therefore, decreased growth of the plant is not the best approach as a basis to understand the causes of symptom manifestation. The specific function of an essential element, and it appears there may be numerous functions, will be related to the resulting growth manifestation. The initial growth manifestations are, as a rule, the most characteristic since it is often difficult by postmortem to determine the cause of death.

The probable basis for symptom manifestation has remained obscure except for a few cases previously mentioned, such as magnesium deficiency which is essential for chlorophyll formation and results in a characteristic chlorosis of plants. Evidence has recently been accumulated that there is a build-up of amino acids (69, 70) in tobacco plants suffering from some of the above-mentioned deficiencies. Some of the amino acids have produced in tobacco plants growth manifestations resembling symptoms produced by mineral element deficiencies.

Summary

The primary group of elements including nitrogen, phosphorus, and potassium is the one most commonly deficient in soils that fail to produce nor-

mal plant growth. Trends toward the use of relatively pure chemicals supplying only these three have resulted in characteristic growth effects when in short supply for each of the secondary group including magnesium, sulphur, or calcium.

When the six elements of the primary and secondary groups were supplied, the micro-elements, boron, copper, iron, manganese, molybdenum, and zinc, have been added one by one to the list of elements essential to plant growth and health under field conditions.

Shortages of magnesium for tobacco and other plants result in a typical chlorosis which has been called "sand drown" in tobacco. The yellows disease of the tea bush has been found to be due to sulphur deficiency. Striking effects on plant growth occur when the element calcium is in short supply.

Top-rot of tobacco, heart- and dry-rot of sugar beets, internal browning of cauliflower, internal cork of apples, and cracked stem of celery have been shown to be due to boron deficiency. The wither-tip symptom is characteristic of copper deficiency, and in the case of tobacco there is a more or less characteristic leaf spot. Iron chlorosis of the young leaves is the most common early symptom with plants; while with manganese deficiency, the chlorosis is characteristically accompanied by necrotic spotting of the young leaves. A shortage of molybdenum results in a chlorosis and necrosis of the older leaves. A chlorosis, necrosis, and shedding of the older leaves characterize zinc deficiency.

The specific and varied function of each of these elements for normal plant growth is not well understood. It has been shown, for example, that magnesium is necessary for chlorophyll formation but the function of some of the other elements is not too clear. Some evidence has been reported that amino acids accumulate in plants that are deficient in some of the above elements, which may be a partial explanation of the symptom manifestation of plants deficient in some of the micro-nutrient elements.

BIBLIOGRAPHY

1. Agulhon, H. Recherches sur la présence et la rôle du bore chez les végétaux. Thèse. Paris, 158 pp. 1910.
2. Alben, A. O., Cole, J. R., and Lewis, R. D. New developments in treating pecan rosette with chemicals. Phytopath. 22: 979-981. 1932.
3. Alben, A. O., Hammar, H. E., and Sitton, B. G. Some nutrient deficiency symptoms of the pecan. Amer. Soc. Hort. Sci. Proc. (1941) 41:53-60. 1942.
4. Allison, R. V., Bryan, O. C., and Hunter, J. H. The stimulation of plant response on the raw peat soils of the Florida Everglades through the use of copper sulphate and other chemicals. Fla. Agr. Exp. Sta. Bul. 190. 80 pp. 1927.
5. Anderson, A. J. Molybdenum deficiency on a South Australian Ironstone soil. Jour. Australian Inst. Agr. Sci. 8:73-75. 1942.
6. Arnon, D. I. and Stout, P. R. Molybdenum as an essential element for higher plants. Pl. Phys. 14:599-602. 1939.
7. Askew, H. O. The boron status of fruit and leaves in relation to "internal cork" of apples in the Nelson District. New Zeal. Jour. Sci. & Tech. 17:388-391. 1935.
8. Barnette, R. M., Camp, J. P., and Warner, J. D. A study of "chlorosis" in corn plants and other field crop plants. Fla. Agr. Exp. Sta. Ann. Rep. 49-50. 1933-34.
9. Barnette, R. M. and Warner, J. D. A response of chlorotic corn plants to the application of zinc sulphate to the soil. Soil Sci. 39:145-156. 1935.
10. Barnette, R. M., Camp, J. P., Warner, J. D., and Gall, O. E. The use of zinc sulphate under corn and other field crops. Fla. Agr. Exp. Sta. Bul. 292. 1936.
11. Bortels, H. Molybdön als katalysator bei der biologischen stickstoffbruding. Arch. Microbiol. 1:333-342. 1930.
12. Brandenburg, E. Eenige gevallen van physiologische ziekten der bieten. I. Meded. Inst. Suikerbiet. Bergen om Zoom 1:89-104. 1931.
13. Brandenburg, E. Hartrot-oorzaak en bestrijding: II. Meded. Inst. Suikerbiet. Bergen om Zoom 2:43-75. 1932.
14. Brenchley, W. E. and Thornton, H. G. The relation between the development, structure, and functioning of the nodules on *Vicia faba*, as influenced by the presence or absence of boron in the nutrient

medium. Roy. Soc. (London) Proc. (B) 98:373-399. 1925.

15. Brenchley, W. E. and Warington, K. The role of boron in the growth of Plants. Ann. Bot. (London) 41:167-187. 1927.
16. Carne, W. M. Grey speck disease of wheat and oats (known as white wilt in Western Australia). Jour. Dep. Agr. West Aust. II. 4:515-519. 1927.
17. Chandler, W. H. Zinc as a nutrient for plants. Bot. Gaz. 98:625-646. 1937.
18. Chandler, W. H., Hoagland, D. R., and Hibbard, P. L. Little-leaf or rosette in fruit trees. I. Amer. Soc. Hort. Sci. Proc. 28(1931):556-560. 1932.
19. Chandler, W. H., Hoagland, D. R., and Hibbard, P. L. Little-leaf or rosette in fruit trees. II. Amer. Soc. Hort. Sci. Proc. 29(1932):255-263. 1933.
20. Chandler, W. H., Hoagland, D. R., and Hibbard, P. L. Little-leaf or rosette in fruit trees. III. Amer. Soc. Hort. Sci. Proc. 30(1933):70-86. 1934.
21. Chandler, W. H., Hoagland, D. R., and Hibbard, P. L. Little-leaf or rosette in fruit trees. IV. Amer. Soc. Hort. Sci. Proc. 32(1934):11-19. 1935.
22. Davies, D. W. and Jones, E. T. Grey speck disease of oats. Welsh Jour. Agr. 7:349-358. 1931.
23. Dearborn, C. H. and Raleigh, G. J. A preliminary note on the control of internal browning of cauliflower by the use of boron. Amer. Soc. Hort. Sci. Proc. 33(1935):622-623. 1936.
24. Dennis, R. W. G. The relation of boron to plant growth. Sci. Prog. 32:58-69. 1937.
25. Dennis, R. W. G. and O'Brien, D. G. Boron in Agriculture. West of Scot. Agr. Col. Res. Bul. 5. 1937.
26. Elze, D. L. Molybdenum injury of tomato plants. Palest. Jour. Bot. 3 No. 1-2 R. Ser. 154-157. 1940.
27. Ferguson, W. S. "Teart" of Somerset: a molybdenosis of farm animals. Proc. Nutr. Soc. (Eng. & Scot.) 1:215-219 discussion 219-20. 1944.
28. Ferguson, W. S., Lewis, O. H., and Waston, S. J. Action of molybdenum in nutrition of milking cattle. Nature 141, 553. 1938.
29. Floyd, B. F. Dieback, or exanthema of citrus trees. Fla. Agr. Exp. Sta. Bul. 140. 31 pp. 1917.
30. Fricke, E. F. Pasture establishment on Ironstone soil at Cressy. Molybdenum deficiency. Tasmanian Jour. Agr. 14: 69-73. 1943.
31. Fricke, E. F. Molybdenum deficiency in oats. Jour. Austral. Inst. Agr. Sci. 13: 75-76. 1947.
32. Garner, W. W., McMurtrey, J. E., Jr., Bacon, C. W., and Moss, E. G. Sand drown, a chlorosis of tobacco due to magnesium deficiency, and the relation of sulphates and chlorides of potassium to the disease. Jour. Agr. Res. 23:27-40. 1923.
33. Garner, W. W., McMurtrey, J. E., Jr., and Moss, E. G. Sand drown, a chlorosis of tobacco and other plants resulting from magnesium deficiency. Science 56:341-342. 1922.
34. Gerretsen, F. C. Manganese deficiency of oats and its relation to soil bacteria. Ann. Bot. 1:207-230. 1937.
35. Gile, P. L. and Carrero, J. O. Cause of lime-induced chlorosis and availability of iron in the soil. Jour. Agr. Res. 20:33-62. 1920.
36. Gris, Eusebe. Nouvelles expériences sur l'action des composés ferrugineux soluble, appliqués à la végétation, et spécialement au traitment de la chlorose et de la débilité des plantes. Compt. Rend. Acad. Sci. (Paris) 19:1118-1119. 1844.
37. Gris, E. Addition à une précédente. Note concernant des expériences sur l'application des sels de fer à la végétation, et spécialement au traitement des plantes chlorosées, languissantes et menacées d'une mort prochaine. Compt. Rend. Acad. Sci. (Paris) 25:276-278. 1847.
38. Hambidge, Gove (editor) Hunger Signs in Crops—a symposium. Washington, D. C. 1941.
39. Javillier, M. Recherches sur la présence et le rôle du zinc chez les plantes. Thèse. Paris. 118 pp. 1908.
40. Jenson, H. L. Root nodule formation and nitrogen fixation in leguminous plants. Austr. Jour. Sci. 3:98-99. 1941.
41. Johnson, M. O. The spraying of yellow pineapple plants on manganese soils with iron sulphate solutions. Hawaii Agr. Exp. Sta. Press Bul. 51. 11 pp. 1916.
42. Johnson, M. O. Manganese as a cause of the depression of the assimilation of iron by pineapple plants. Jour. Ind. & Eng. Chem. 9:47-49. 1916.
43. Johnson, M. O. Manganese chlorosis of pineapples: its cause and control. Hawaii Agr. Exp. Sta. Bul. 52. 38 pp. 1924.
44. Johnson, M. O. Control of chlorosis of the pineapple and other plants. Jour. Ind. & Eng. Chem. 20:724-725. 1928.
45. Johnston, E. S. and Dore, W. H. The influence of boron on the chemical composition and growth of the tomato plant. Plant Physiol. 4:31-62. 1929.

46. Johnston, E. S. and Fisher, P. L. The essential nature of boron to the growth and fruiting of the tomato. Plant Physiol. 5:387-392. 1930.

47. Kleinholz, J. R. Boron deficiency in pear trees. Phytopath. 32:1082-1087. 1942.

48. Knott, J. E. The effect of certain mineral elements on the color and thickness of onion scales. N. Y. (Cornell) Agr. Exp. Sta. Bul. 552. 14 pp. 1933.

49. Kotila, J. E. and Coons, G. H. Boron deficiency disease of beets. Previously known only in Europe, investigations have revealed its presence in Michigan and Ohio. Facts about Sugar 30:373-376. 1935.

50. Kuijper, J. Boorzuur tegen de topziekte van de tabak. Deli-Proefsta. Medan Vlugschr. 50:7 pp. 1930.

51. Lee, H. A. and McHargue, J. S. The effect of a manganese deficiency on the sugar cane plant and its relationship to Pahala blight of sugar cane. Phytopath. 18:775-786. 1928.

52. McHargue, J. S. The role of manganese in plants. Jour. Amer. Chem. Soc. 44: 1592-1598. 1922.

53. McHargue, J. S. Effect of different concentrations of manganese sulphate on the growth of plants in acid and neutral soils and the necessity of manganese as a plant nutrient. Jour. Agr. Res. 24: 781-794. 1923.

54. McMurtrey, J. E., Jr. The effect of boron deficiency on the growth of tobacco plants in aerated and unaerated solutions. Jour. Agr. Res. 38:371-380. 1929.

55. McMurtrey, J. E., Jr. Distinctive effects of the deficiency of certain essential elements on the growth of tobacco plants in solution cultures. U. S. Dept. Agr. Tech. Bul. 340. 43 pp. 1933.

56. McMurtrey, J. E., Jr. Boron deficiency in tobacco under field conditions. Jour. Amer. Soc. Agron. 27:271-273. 1935.

57. McMurtrey, J. E., Jr. Symptoms on field-grown tobacco characteristic of the defiecient supply of each of several essential chemical elements. U. S. Dept. Agr. Tech. Bul. 612, 30 pp. 1938.

58. McMurtrey, J. E., Jr. and Robinson, W. O. Neglected soil constituents that affect plant and animal development. U. S. Dept. Agr. Yearbook 1938:807-829. 1938.

59. Mazé, P. M. Note sur les chloroses des végétaux. Compt. Rend. Soc. Biol. (Paris) 77:539-541. 1914.

60. Mowry, H. and Camp, A. F. A preliminary report on zinc sulphate as a corrective for bronzing of tung trees. Fla. Agr. Exp. Sta. Bul. 273. 34 pp. 1934.

61. Olsen, C. The absorption of manganese by plants. Compt. Rend. Lab. Carlsberg 20:34 pp. 1934.

62. Olsen, C. Iron absorption and chlorosis in green plants. Compt. Rend. Lab. Carlsberg (Ser Chim.) 21:15-52. 1935.

63. Purvis, E. R. and Ruprecht, R. W. Cracked stem of celery caused by a boron deficiency in the soil. Fla. Agr. Exp. Sta. Bul. 307. 16 pp. 1937.

64. Samuel, G. and Piper, C. S. Grey speck (manganese deficiency) disease of oats. Jour. Dept. Agr. So. Aust. 31:696-705, 789-799. 1928.

65. Schreiner, O. and Dawson, P. R. Manganese deficiency in soils and fertilizers. Indus. & Engin. Chem. 19:400-404. 1927.

66. Sommer, A. L. Further evidence of the essential nature of zinc for the growth of higher green plants. Plant Physiol. 3:217-222. 1928.

67. Sommer, A. L. and Lipman, C. B. Evidence of the indispensable nature of zinc and boron for higher green plants. Plant Physiol. 1:231-249. 1926.

68. Steinberg, R. A. Relation of accessory growth substances to heavy metals including molybdenum in the nutrition of *Aspergillus niger*. Jour. Agr. Res. 52:439-448. 1936.

69. Steinberg, R. A., Bowling, J. D., and McMurtrey, J. E., Jr. A possible explanation of symptom formation in tobacco with frenching and mineral deficiencies. Science 110 (No. 2870):714-715. 1949.

70. Steinberg, R. A., Bowling, J. D., and McMurtrey, J. E., Jr. Accumulation of free amino acids as a chemical basis for morphological symptoms in tobacco manifesting frenching and mineral deficiency symptoms. Plant Physiol. 25 (No. 2):279-288. 1950.

71. Storey, H. H. and Leach, R. A sulphur-deficiency disease of the tea bush. Ann. Appl. Biol. 20:23-56. 1933.

72. Swannback, T. R. The effect of boric acid on the growth of tobacco plants in nutrient solutions. Plant Physiol. 2:475-486. 1927.

73. Townsend, G. R. and Wedgworth, H. H. A manganese deficiency affecting beans. Fla. Agr. Exp. Sta. Bul. 300. 23 pp. 1936.

74. Walker, Richard B. Molybdenum deficiency in serpentine barren soils. Science 108:473-475. 1948.

75. Waring, E. J., Shirlow, N. S., and Wilson, R. D. Molybdenum in relation to whiptail of cauliflower. Jour. Aust. Inst. Agr. Sci. 13:187-188. 1947.

76. Warington, K. The effect of boric acid and borax on the broad bean and certain other plants. Ann. Bot. (London) 37: 629-672. 1923.

77. Warington, K. The changes induced in the anatomical structure of *Vicia faba* by the absence of boron from the nutrient solution. Ann. Bot. 40:27-42. 1926.

78. Warington, K. Studies in the absorption of calcium from nutrient solutions with special reference to the presence or absence of boron. Ann. Bot. 48:743-776. 1934.

79. Willis, L. G. Bibliography of references to the literature on the minor elements and their relation to the science of plant and animal nutrition. Chilean Nitrate Educational Bureau. New York. 396 pp. (Fourth edition). 1948.

80. Wilstätter, Richard. Zur Kenntnis der Zusammensetzung des Chlorophylls. Justus Liebig's Ann. Chem. 350:48-82. 1906.

Variations Improve Hope for Better Legumes

MEN have said for generations that "like breeds like," but of the many possibilities for improvement, natural variation stands out as one of the best. "Like" occasionally breeds "unlike." Nevertheless, notable changes are surprising; sometimes even the place of change is surprising to most people.

To a soil bacteriologist, however, a nodule on a plant rootlet is not a surprising location in which to find changes advantageous to the farmer. On all sorts of legume crops, U. S. Department of Agriculture and State scientists find that studies of individual nodules show as much variation as between above-ground plants. Nodules reveal all degrees of efficiency in nitrogen fixation. Bacteria in one nodule may be high fixers; in another nearby they may be low; in the next medium. Some of the tight little groups may fix no nitrogen at all—may be parasitic, living rent-free and even taking nourishment from the plant.

At the Plant Industry Station of the Department such strain variation among nodule bacteria has been found for all legumes studied. Some strains are parasitic on one kind of plant and contributing citizens of a symbiotic (help-each-other) society in another. For example, a strain parasitic on crimson clover is one of the best nitrogen accumulators on white or red clover. But another strain that pays its way well on crimson clover is also one of the best on white and red; so in making cultures it may be possible to rule out altogether the one that is bad for a certain legume.

The peculiarities of some strains of bacteria have amazed even the scientists who know the legumes from A to Z. A case involves two strains of fixers from ladino clover nodules and two from white clover nodules. Not one of the four did a thing for ladino, not even those that had accepted ladino hospitality; but all four were good on white clover.

The symbiotic relationship between legumes and bacteria is reflected in the relationship between legume breeder and soil bacteriologists. The breeder's new strain of a legume may need a more effective nitrogen fixer. The bacteriologists know where to look and feel pretty sure of finding such a fixer. On the other hand, the breeders feel just as sure that now and then they'll create new strains of legumes that can make good use of some of those bad bacteria (which, by the way, the bacteriologists keep in their living museums just in case proper associations may be found for them).

Soil-saving Plans Basis for Credit

A COPY of the farm plan for soil conservation "should be made available to banks and become a part of the farmer's credit file." This is one of the recommendations of the American Bankers Association in "A Program For Country Banks—1951," issued by its Agricultural Commission. This, says the U. S. Department of Agriculture, is in accord with the basic philosophy of the Soil Conservation Service —that land or soil is sound basis for agricultural credit when it is conserved by being kept in its place and not allowed to erode away, and when use of the land is planned on the basis of its continuing use for the purposes to which it is best adapted.

Bankers, says their Association, should "encourage the development of a sound conservation plan for every farm and ranch in the Nation."

Three other country-bank projects proposed were:

"Develop a credit program to financially support soil-improvement practices;

"Work up a plan of credit to assist farmers in certain areas to change from one-crop agricultural production to that of diversification; and

"Have every state appraise its idle acres—and develop a plan of productive use for them in pastures and timber."

Soil conservation districts, with the aid of the technicians of the Soil Conservation Service, are making progress as rapidly as the work can be done in preparing the programs that warrant support by the bankers. This includes the preparation of the "farm plans" for each farm—which the bankers recommend as "a part of the farmer's credit file."

High-yielding Soil May Need Fertilizer

SOIL tests may show that a soil needs treatment even when yields have been good, according to Lyell Thompson, Extension Agronomist at Ohio State University.

Thompson, who is with the soil inventory laboratory, says, "Some farmers have been surprised to find that their soils have tested low in available phosphorus and potash even though crop yields have been high."

Well-managed soils, in a high state of tilth, often release their nutrients and continue to produce high yields until they are in a low state of fertility. Such soils may continue to produce high yields if they are given maintenance applications of fertilizer.

Results of a soil test on such soils will indicate just how near the critical nutrient level they are. Tests also will show how necessary fertilization is to maintain high yields.

Gray-colored, poorly-drained soils that do not show good tilth must be maintained in a higher state of fertility if maximum production is expected from them, Thompson declares. These soils release their nutrients to crops slowly. A test on such soils may show them to be high in available phosphorus and potash even though yields are low.

Farmers who want their soils tested should contact their county extension office.

Old Sugarcanes Giving Way to New Ones

A SURVEY recently with the help of the agricultural extension agents in the 18 main sugar-producing parishes of Louisiana, and reported by Dr. George Arceneaux of the U. S. Department of Agriculture, showed that at present one-third of the State's sugarcane acreage is of the variety C. P. 36/105. This variety has increased eightfold since 1947.

Further showing how the battle for improvement goes, the variety C. P. 34/120 dropped off more than 5 per cent last year. C. P. 36/105 went up 12.85 per cent. Ten years ago neither of these two varieties was found in commercial plantings. Co. 290, one of the early introductions from India, and at present a bad third with less than 10 per cent of the State's acreage, lost nearly 7 per cent.

The breeding of new sugarcane varieties in the United States began in earnest with the introduction by the U. S. Department of Agriculture of mosaic-resistant varieties from India and the Dutch East Indies about 25 years ago, when the disease had about ruined the sugar industry of Louisiana. Since that time new varieties bred from high-yielding and disease-resistant foundation stocks have been released by the Department's Division of Sugar Plant Investigations, most of them developed on the U. S. Station at Canal Point, Fla. Now practically all of the surgarcane grown in Louisiana, the principal sugarcane area, is of varieties bearing the Station's initials "C. P." and a number.

The old varieties of the days when mosaic disease began mowing them down have disappeared entirely, according to Dr. Arceneaux. "Not only have the new Department-bred varieties taken over," he says, "but new C. P.'s are continually pushing old C. P.'s down into lower percentage rating and finally out of the acreage ratings."

New factors are demanding considertion of the breeders as the years go by. As an illustration, Arceneaux mentioned a new variety C. P. 36/183 which occupies a little more than 1 per cent of the acreage. "It has," he says, "a shortcoming greatly limiting its usefulness under present-day conditions—a tendency to lodge which makes it unsatisfactory for mechanical harvesting."

The Challenge

"American agriculture—American farmers, if you please—face a tremendous challenge, one of the greatest in our history. Here briefly, is the job farmers are expected to do:

"They must produce enough to supply the Nation's growing military forces with food and the growing defense industries with raw materials.

"They must produce enough to supply with good diets the 150 million people who make up the Nation's civilian population and, so far as it is possible, enough more to carry at the same time a safe margin of strategic reserves.

"They must produce enough to back up the Nation's foreign policy by enabling us to continue to share our food and fiber to the fullest possible extent under sound arrangements with friendly countries in need of help." *Secretary of Agriculture Charles F. Brannan.*

Things Are Better . . .

(*From page* 5)

sources for good farm house plans which are often expansible, frequently one-story ranch style, or other modern architectural patterns. The average farm house of the nation in 1950 had five rooms, but that is not the whole of it. Houses with but one and two rooms represented only 5 per cent of the farms, those having three to four rooms were 31 per cent, five to six rooms 37 per cent, and with seven or more rooms 27 per cent. But the North had 46 per cent of all its farms with seven-room houses or better.

SMALLER families create the design for rural living quarters. No longer do we have to raise our work replacements, so that the fellow with the most kids is the one who will succeed the best in agriculture. If we design farm homes with more than the average room spaces we do it to get a sense of expanded comfort rather than mere accommodation. Taking one person per room as the standard upper limit in housing space, the proportion of occupied housing on farms with more than one person per room declined from 30 per cent in 1940 to 22 per cent in 1950. In the North in 1950 we had 10 per cent of the occupied farm houses with over one person per room. It stood at 20 per cent in the West and was still around the 1940 figure of 30 per cent in the South.

House planning in the country is a far different task than it is in the city. Numerous work necessities and the close partnership of the household and the great outdoors are the essential basic urges which determine the design and arrangement. Pick up any modern farm magazine and scan its picture pages to see how far, wide, and handsome we have come in providing more than shelter and a roosting place for our farm folks after chore time. Gracious living and warm hospitality are possessed now by more farm families than ever before as reflected in their homes. Fewer older folks quit and hit for a cottage in town these days for this reason.

The old well and the long lug to the kitchen have begun to vanish, as they should. Farms need and can use more running water than any segment of society, possibly excepting miners. Sanitation is at the hub of the farmer's universe, making cleanliness in person and product of paramount importance. The 1950 census figures indicated that 42 per cent of all our farms enjoyed running water facilities, that is, in the dwellings. Along about the time when World War I ended, only 10 per cent of our farms had this convenience. The sources of the water supplies for drinking and cooking purposes show that wells furnish 80 per cent, natural springs of poetic lore provide 7 per cent, and 3 per cent come from municipal water mains. Combined bathtubs, flush toilets, and hot running water were listed in 23 per cent of all farm homes in 1950, but 57 per cent had kitchen sink facilities.

IN the cold climate of the North 33 per cent of all farms had some form of central furnace heating in 1950, with 67 per cent sticking to fuel burners in the various rooms. Use of coal and wood in the heating of farm houses declined somewhat in 10 years while burning of oil and gas increased. A fifth of the Southern farm homes did not use either stoves or furnaces at all.

Roads that can be traveled in all kinds of weather with relative ease and safety are a boon to rural life. In 1950, 65 per cent of all our farms were located on such highways, against only 25 per cent back in 1925. Naturally,

the advent of the motor car and power truck sped up this great change—making almost every farm an integral part of the larger community.

"What does this panorama of change signify to the whole country, as well as to the farmers?" It isn't hard to find a logical answer.

America is more dependent on the skill and resources of our farms and soils today than ever, while the opposite is also true—that without the industrial production of our cities the farmers would be denied the means to maintain their enormously increased output.

WE used to imagine that the rural workers were in a special class by themselves, famous for their ingenuity and self-reliance. Some even said they were the *only* producers of wealth and value. It took a long, long time for the ancient homecrafts and native skills to languish and decline in the open, isolated countryside. Now we try to revive them and give prizes to retain them, and they assume the place of museum curiosities. It has gone so far that some farm boys do not know how to harness a team or even milk a cow.

However that may be, we have closed tight the yellow leaves of the ancient book of rural days and ways. From now onward we hitch our agricultural wagon to the stars of science and progress, and farms as well as factories would be silent and workless if anything happens to the gadgets we are dependent upon.

On the positive side we have reached a point where our farms can produce 70 per cent more than they did 40 years ago on only about 10 per cent more arable land, but with 20 per cent fewer farm workers. Something has "been added." That something is steel, chemicals, and electric power. We have substituted the products of non-farmers for the labor we have lost and the time we have saved on farms.

Today they tell us that 25 million wage-earners out of about 62 million gainfully employed in this country are catering to farms in one or more ways. Of these, 10 million are running the farms, 9 million are processing and distributing the products of the farm, while 6 million are engaged in making goods and providing services directly for the army on the land.

What do our farms require each year from non-farm producers in order to get square meals for the best-fed nation in the world? Of steel they use more than is required to make all our passenger vehicles, 25 per cent of all the petroleum and oil products consumed, enough crude rubber to make tires for 6 million autos, and 15 billion kilowatt hours of juice which would keep the dynamos running in four of our larger cities. The magnitude of the chemicals now utilized in hundreds of ways by farmers is beyond comprehension. It is big enough at least to warrant a senate committee to prepare a fine analysis of the subject.

WE both can recall when simple things were heralded as mighty discoveries and only short, hesitating steps were being taken on this glory road of science. The use of a ragdoll seed tester, the proper care of the sitting hen, the right way to cure seed corn in racks not exposed to winter weather, dosing potatoes with paris green, testing soil acidity with sheets of litmus paper, cooking feed for hogs over fires, and lighting our homes with battery sets were some of them.

For the most part in those times farmers were loath to accept and turn to newer things. In these present days science has to hustle hard to keep ahead of the keen demands generated by hard-pressed farmers with capital investments many times more burdensome to manage than was the case in former times. Help is scarce and costly; production has become more and more specialized and insistent. Our ways become the world's ways and

we extend ourselves and our resources to feed our growing population on the one hand and seek to liberate and make more efficient the land workers of foreign nations on the other. American agriculture never faced a bigger problem or had so much reliance placed upon its efforts.

Therefore when we believe that our farmers are less concerned with the old radical ideas and less often show evidence of unrest and dissatisfaction, we see just one outward aspect of the picture. Under all this superficial and apparent calmness of theirs lies a deep-rooted conviction that they face some kind of a grave destiny. They do not harp about it or use big, stagy phrases to recite it in a public way, but beneath it all they are always thinking, planning, persevering, hoping, forever learning—praying for peace, to be sure, but not the kind that comes cheaply.

OF course, there are certain legislative safeguards and traditions respecting their craft and the incentives and protections inherent in it which are accepted in general. But farmers are still individualistic even after all these years of cooperation. They sense that these new things and strange chemicals and processes which they must learn to use and live with are here to stay. The old era is dead and gone. What stirred men's minds in rural forums half a century ago no longer strikes a spark. Each farmer is bound by necessity, if not always by convenience or desire, to strike right out into the new zones of different methods and make his way among the formulas and the push buttons and the dynamos, the gears and differentials and the logistics of the new agriculture.

So, my friends, we are a changed and a changing people. But not for one moment do we have the least inclination to feel that our farmers will fail us—even amid the turmoil and the terminology of science and the twilight zone of half peace and half war.

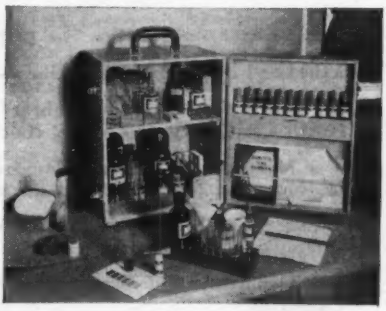
Time Proven LaMotte Soil Testing Apparatus

LaMotte Soil Testing Service is the direct result of 30 years of extensive cooperative research with agronomists and expert soil technologists to provide simplified soil testing methods. These methods are based on fundamentally sound chemical reactions adapted to the study of soils, and have proved to be invaluable aids in diagnosing deficiencies in plant food constituents. These methods are flexible and are capable of application to all types of soil with proper interpretation to compensate for any special soil conditions encountered.

Methods for the following are available in single units or in combination sets:

Ammonia Nitrogen	**Iron**
Nitrate Nitrogen	**pH (acidity & alkalinity)**
Nitrite Nitrogen	**Manganese**
Available Potash	**Magnesium**
Available Phosphorus	**Aluminum**
Chlorides	**Replaceable Calcium**
Sulfates	

Tests for Organic Matter and Nutrient Solutions (hydroculture) furnished only as separate units.



LaMotte Combination Soil Testing Outfit

Standard model for pH, Nitrate, Phosphorus and Potash. Complete with instructions.

Illustrated literature will be sent upon request without obligation.

LaMotte Chemical Products Co.

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FREE LOAN OF EDUCATIONAL FILMS

The American Potash Institute will be pleased to loan to educational organizations, agricultural advisory groups, responsible farm associations, and members of the fertilizer trade the motion pictures listed below. This service is free except for shipping charges.

FILMS (ALL 16 MM. AND IN COLOR)

The Plant Speaks Thru Deficiency Symptoms (Sound, running time 25 min. on 800-ft. reel.)

The Plant Speaks, Soil Tests Tell Us Why (Sound, running time 10 min. on 400-ft. reel.)

The Plant Speaks Thru Tissue Tests (Sound, running time 14 min. on 400-ft. reel.)

The Plant Speaks Thru Leaf Analysis (Sound, running time 18 min. on 800-ft. reel.)

Save That Soil (Sound, running time 28 min. on 1200-ft. reel.)

Borax From Desert to Farm (Sound, running time 25 min. on 1200-ft. reel.)

Potash Production in America (Sound, running time 25 min. on 800-ft. reel.)

In the Clover (Sound, running time 25 min. on 800-ft. reel.)

In Canada: The Plant Speaks Thru Deficiency Symptoms
The Plant Speaks, Soil Tests Tell Us Why
The Plant Speaks Thru Tissue Tests
The Plant Speaks Thru Leaf Analysis
Borax From Desert to Farm

DISTRIBUTORS

Northeast: Educational Film Library, Syracuse University, Syracuse 10, N. Y.

Southeast: Vocational Film Library, Department of Agricultural Education, North Carolina State College, Raleigh, North Carolina.

Lower Mississippi Valley and Southwest: Bureau of Film Service, Department of Educational Extension, Oklahoma A & M College, Stillwater, Oklahoma.

Midwest: Visual Aid Service, University Extension, University of Illinois, Champaign, Illinois.

West: Department of Visual Education, University of California, Berkeley 4, California.
Department of Visual Education, University of California Extension, 405 Hilgard Ave., Los Angeles 24, California.
Department of Visual Instruction, Oregon State College, Corvallis, Oregon.
Bureau of Visual Teaching, State College of Washington, Pullman, Washington.

Canada: National Film Board, Ottawa, Ontario, Canada.

IMPORTANT

Requests should be made well in advance and should include information as to group before which the film is to be shown, date of exhibition (alternative dates if possible), and period of loan.

Request bookings from your nearest distributor.

AVAILABLE LITERATURE

The following literature on the use of fertilizers in profitable soil and crop management is available for distribution. We shall be glad to send these upon request and in reasonable amounts as long as our supply lasts.

Circulars

Tomatoes (General)
Asparagus (General)
Vine Crops (General)
Better Corn (Midwest)
The Cow and Her Pasture (General)

Reprints

F-3-40 When Fertilizing, Consider Plant-food Content of Crops
S-5-40 What Is the Matter with Your Soil?
Y-5-43 Value & Limitations of Methods of Diagnosing Plant Nutrient Needs
A-1-44 What's in That Fertilizer Bag?
QQ-12-44 Leaf Analysis—A Guide to Better Crops
P-3-45 Balanced Fertility in the Orchard
Z-5-45 Alfalfa—The Aristocrat
OO-8-45 Potash Fertilizers Are Needed on Many Midwestern Farms
ZZ-11-45 First Things First in Soil Fertility
T-4-46 Potash Losses on the Dairy Farm
Y-5-46 Learn Hunger Signs of Crops
I-3-47 Fertilizers and Human Health
T-4-47 Fertilizer Practices for Profitable Tobacco
AA-5-47 The Potassium Content of Farm Crops
TT-11-47 How Different Plant Nutrients Influence Plant Growth
VV-11-47 Are You Pasture Conscious?
R-4-48—Needs of the Corn Crop
X-6-48 Applying Fertilizers in Solution
AA-6-48 The Chemical Composition of Agricultural Potash Salts
GG-10-48 Starved Plants Show Their Hunger
OO-11-48 The Use of Soil Sampling Tubes
CC-8-49 Efficient Vegetable Production Calls for Soil Improvement
KK-10-49 An Approved Soybean Program for North Carolina
SS-12-49 Fertilizing Vegetable Crops
F-1-50 A Simplified Field Test for Determining Potassium in Plant Tissue
I-2-50 Boron for Alfalfa
K-3-50 Metering Dry Fertilizers and Soil Amendments into Irrigation Systems
L-3-50 Food for Thought About Food
O-4-50 Birdsfoot Trefoil—A Promising Forage Crop
V-5-50 Potassium Cures Cherry Curl Leaf
X-5-50 Fertilizers Help Make Humus
AA-8-50 Alfalfa—Its Mineral Requirements and Chemical Composition
BB-8-50 Trends in Soil Management of Peach Orchards
HH-11-50 The Minor Element Problem
II-11-50 Tree Symptoms and Leaf Analysis Determine Potash Needs
A-1-51 Soil-testing Reduces Guesswork
I-2-51 Soil Treatment Improves Soybeans
K-3-51 Increasing Cotton Yields in North Carolina
M-3-51 A Look at Alfalfa Production in the Northeast
O-4-51 More Corn at No Extra Cost
P-4-51 Thirty Tons of Tomatoes per Acre
S-5-51 The Development of the American Potash Industry
W-6-51 Does Potash Fertilizer Reduce Protein Content of Alfalfa?
X-8-51 Orchard Fertilization Ground and Foliage
BB-10-51 Healthy Plants Must Be Well Nourished
CC-10-51 Producing Small Grain More Efficiently
DD-10-51 Fertilizers for Vegetable Crops, Rates, Placement, and Ratios
EE-10-51 Rotation Fertilization
GG-11-51 Fertilizer Recommendations Based on Soil Tests
HH-11-51 Concerning "Bio-dynamic Farming" and "Organic Gardening"
II-12-51 Pasture Improvement With 10-10-10 Fertilizer
JJ-12-51 Soil Fertility and Pastures
KK-12-51 Potassium in Animal Nutrition
A-1-52 Research Points the Way to Higher Levels of Peanut Production
C-2-52 Potash Needs Move West
D-2-52 Boron for Forage Crops
E-2-52 Ladino Clover—Its Mineral Requirements & Chemical Composition
F-2-52 Half Way There
G-3-52 Alabama's Experience With Alfalfa
H-3-52 The Relative Merits of Inorganic & Organic Sources of Plant Nutrients
I-3-52 The Magic of Nitrogen
J-3-52 Inventorying Soil Improvement
K-3-52 Pastures Pay Profits in Louisiana
L-4-52 Efficient Use of Fertilizer in the Southern Region
M-4-52 The Inorganic Side of Life
N-4-52 Use of a Soil Test Summary in Agronomic Programs
O-4-52 Tomato Production for the Canning Industry
P-4-52 Soybeans Need Fertilizer on Many Arkansas Rice Farms
Q-5-52 Potassium-nitrogen Balance for High Corn Yields
R-5-52 Why Plants Differ in Fertilizer Need and Mineral Composition
S-6-52 Better Potato Yields in Western Maryland

THE AMERICAN POTASH INSTITUTE
1102 16TH STREET, N. W. WASHINGTON 6, D. C.

She—"Dearest, is there anything in life but love?"

He—"Nothing, sweet. Will dinner be ready soon?"

* * *

Recruiting Officer—"And now just one more question: 'Who is your next of kin?' "

Negro Volunteer—"Whuffoh yo' wants to know dat?"

"Well, in case you were killed we'd have to know where to send the body."

"Now looky heah, Kunnel—ef'n dat's de case Ah saves yo' de trouble. Ah jes' takes de body wif me an' thanks yo kindly. Good'by!"

* * *

Dentist — "Open wider, please—wider."

Patient—"A-A-A-A-Ah."

Dentist — (inserting rubber gag, towel, and sponge)—"How's your family?"

* * *

Only a woman can rave over a pair of nylon stockings when they're empty.

* * *

The young stenographer was being given her first instructions by the boss.

"There are two words that I never want to hear you use around here," he said. "One is lousy and the other is terrific."

"OK," replied the girl. "What are the words?"

"Why is Fred on the outs with Marguerite, Mayme?"

"He rose hastily when her mother entered the parlor."

"Well, a gentleman should rise—"

"And dropped the girl on the floor."

* * *

Once upon a time there were two old maids named Binnie and Winnie who lived alone except for their pedigreed cat named Minnie. Now these ladies had such Victorian ideas on the subject of modern living that, for years, neither they nor their cat left the house for fear of "contamination."

One day a man came into the house and wooed the younger of the two ladies, who decided to marry him at once despite the vehement protestations of her sister. Finally realizing that her objections were futile, the older lady said to her sister, "I confess I am curious about married life. Promise me that you will write and tell me about it."

Two days later the spinster received a telegram from her sister with only three words on it . . . LET MINNIE OUT.

* * *

"Suffering from indigestion? Why, just drink a pint of warm water after every meal. What could be simpler?"

"Indigestion."

BORAX... restores lost boron to soil

- Agricultural authorities agree that boron is an essential plant food just as are nitrogen, potash and others. A boron deficiency in soil causes dwindling crops and puny plants... but borax restores lost boron. Users of our fertilizer borates* report increased yields of alfalfa, pasture crops and many vegetable, field and fruit crops, plus greatly improved quality.

* **FERTILIZER BORATE** (*equivalent to approximately 93% borax*) and **FERTILIZER BORATE—HIGH GRADE** (*equivalent to approximately 121% borax*) offer you low-cost, economical sources of boron... in fine mesh for addition to mixed fertilizer, or coarse mesh for direct application where required. County Agents or State Experimental Stations should be consulted for detailed recommendations. Write today for literature and quotations.

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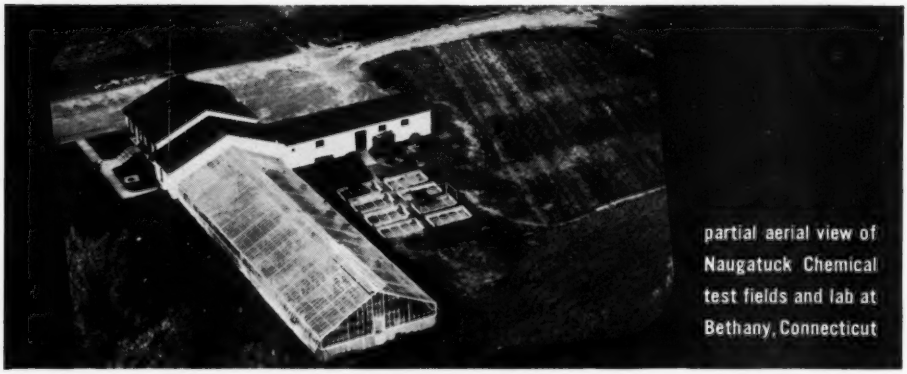

partial aerial view of Naugatuck Chemical test fields and lab at Bethany, Connecticut

Here's where sales are sown!

Here's where Naugatuck chemicals begin — where Spergon®, Phygon® and Aramite* first showed signs of becoming the nationally famous products they are today.

Here's where Naugatuck Chemical's seed protectants, spray fungicides and insecticides of tomorrow must meet the tests of effectiveness, economy, plus ease and safety of use.

Yes, and here's where sales are sown! When the benefits of the Naugatuck chemicals developed here eventually reach the grower, they also reach the supplier and distributor in the form of new sales and new profits.

*U. S. Pat. No. 2,529,494

UNITED STATES RUBBER COMPANY

Naugatuck Chemical Division, Naugatuck, Conn.

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